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CYCLONE MEMOIRS.

PART III.

BAY OF BENGAL CYCLONE

OF

September 13th—20th, and October 27th—31st, 1888,

AND

ARABIAN SEA CYCLONE

OF

November 6th—9th, 1888.

PUBLISHED BY THE METEOROLOGICAL DEPARTMENT OF THE GOVERNMENT OF INDIA UNDER THE DIRECTION OF

J. ELIOT, M.A.,
METEOROLOGICAL REPORTER TO THE GOVERNMENT OF INDIA.

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BAY OF BENGAL AND ARABIAN SEA.

CYCLONE MEMOIRS. PART III.

Account of the Cyclonic Storm of September 13th to 20th, 1888, and of the Cyclone of October 27th to 31st, in the Bay of Bengal, and the Cyclone of November 6th to 9th, 1888, in the Arabian Sea.

By J. ELIOT, M.A.,
Meteorological Reporter to the Government of India.

CHAPTER I.

Introduction.

THE present number of the Cyclone Memoirs contains an account of the two most important cyclonic storms in the Bay of Bengal during the year 1888.

Brief statement of the first storm.—The first of these storms is remarkable for the fact that it was not generated in the Bay, but advanced (probably from the Gulf of Siam) across Tenasserim into the Andaman Sea and the Bay of Bengal. The evidence on this point is very limited, and hence by no means conclusive. It however appears to be sufficient to establish it as the most reasonable hypothesis of its origin. Assuming this to be the case, the storm is the first large cyclone in the Bay of Bengal on record which passed into it from another sea or land area, and hence on this account deserves investigation. The first indications of the storm were shown on the afternoon of the 12th September, when a deepish depression appeared in Tenasserim. It advanced westward across the Gulf of Martaban and South-West Pegu on the afternoon of the 13th and morning of the 14th. It crossed the Bassein hills about 8 A. M. of the 14th, and shortly after passed out into the Bay of Bengal, over which it marched in a west-north-west direction at an average rate of about 14 miles per hour. It was apparently of smallish dimensions and moderate intensity at this time, but increased considerably in its passage across the Bay, and was a fierce and dangerous storm when it approached the Orissa coast. It gave winds and squalls of hurricane force in the north-west angle of the Bay and at False Point, where the barometer fell to 28·85″. The storm centre struck the coast a little to the south of False Point about 2-30 A. M. of the 16th. It advanced into the central districts of the Central Provinces during the next 24 hours. The centre was a little distance to the east of Nagpur at 8 A. M. of the 17th, and probably midway between Nagpur and Raipur. The storm was almost stationary during the next 24 hours, as the centre was a few miles to the north-west of Nagpur at 8 A. M. of the 18th. It was then recurving rapidly from west to north, and afterwards marched in a northerly direction through Central India and East Rajputana on the 18th and 19th, into the south-eastern districts of the Punjab and adjacent districts of the North-Western Provinces on the morning of the 20th, and broke up on the afternoon of that day as it approached the Simla and Mussooree hills. It gave unusually heavy rain over the whole of its track on land, and the rainfall increased in amount as it advanced northwards from the Central Provinces. It hence gave rise to severe floods in Upper India which breached the railways and suspended traffic for some time. The storm lasted for at least eight days, and was remarkable for its peculiar origin, its persistence, its excessive rainfall, and its change of direction from west to north in the Central Provinces after a halt of nearly 24 hours. Although it was a storm of the rains proper, it occurred quite at the end of the season, and approached in intensity to the more severe storms of the transition periods. It was less intense and severe than the October cyclones, and hence will probably be of less interest to sailors than the second and third storms of October and November 1888. It resembled the storms of the rains proper, in that it passed unbroken and unchanged over the Orissa hills, the Satpura and Vindhyas, and was hence a cyclonic storm of high elevation.

Brief statement of second and third storms.—The second storm was generated in the Bay to the south-west of the Andamans on the 27th, 28th, and 29th of October, under what may be termed the usual conditions of storm formation in that month. It marched west by north across the Bay, gathering force as it advanced, and was a large and dangerous cyclone on the morning of the 31st October, when it was approaching the Madras coast. It crossed the coast at Madras late in the evening of that day. It marched in a westerly direction across the Carnatic, and broke up as a cyclonic storm on the evening of the 1st in East Mysore and Bellary. For some days previously weather had been very unsettled and squally in the centre of the Arabian Sea between the meridians of 54° and 68° E. longitude. This area of disturbed weather extended eastwards on the 3rd and 4th, and absorbed the disturbed weather which was transmitted westwards on the breaking up of the cyclone near the West Ghâts. On the 5th and 6th a small cyclonic storm was generated in this area, the centre of which on the 7th was in about Lat. 16° N. and Long. 67½ or 68° E. It began to move to the north-north-east on the evening of that day, and was in Lat. 18° N. and Long. 68¾° E. at noon of the 8th. It was then moving at an average rate of 8 miles per hour and advancing to the Kathiawar coast. It was throughout a comparatively small storm, but very strong winds and an unusually high sea prevailed near the centre. One or two British India steamers passed through it safely, but the coasting steamer *Vaitarna,* a very lightly built steamer fitted for passenger traffic only, encountered the storm on the evening of the 8th off the South Kathiawar coast, and was lost during the night with upwards of 700 native passengers on board. The storm centre crossed the Kathiawar coast on the morning of the 9th, advanced through Kathiawar, and filled up during the next 24 hours in the neighbourhood of the Aravallis.

General weather conditions of India antecedent to the formation of the first storm.—The cold-weather months of January and February 1888 were normal in character. The rainfall in Northern India was not large in amount, but was slightly greater than usual. In the hills, the snowfall was considerably below the normal. Hence temperature began to increase rapidly earlier than usual in March, and the hot-weather months of April and May 1888 were remarkable for the intense heat and dryness of the air over the whole of the interior. In fact higher temperatures were recorded in Upper and Central India than have been registered for several years. The intensity of the heat in March and April was so great as to give rise in April and May to a succession of very severe hot-weather storms (*viz.*, thunder-storms, hail-storms, and dust-storms in the Gangetic plain, and norwesters and tornadoes in Bengal) of almost unexampled severity. For example, a storm at Dacca on the 7th April, which commenced as an ordinary norwester, developed into a tornado that cleared a narrow passage for itself through the town, about 4 miles in length, and 100 to 150 yards in width. Upwards of 100 persons were killed, partly by the force of the wind, and partly by the falling houses. On the 30th of April, a very violent hail-storm passed over the town of Moradabad in Rohilkhand, during which upwards of 200 persons were killed. They were reported to have been beaten to death by the hail-stones, but subsequent enquiry appears to show that many who were killed were unable to find shelter from the fury of the storm, and were first beaten down by the wind and hail and then chilled to death by the hail.

These were the two most remarkable of the hot-weather storms which occurred during the period. Although some of the storms of this period were much more violent than usual, the number of thunder-storms and norwesters was apparently less than usual in Bengal, Assam and Behar.

The conditions at the end of May seemed favourable to the early advance of the south-west monsoon in Bengal. Pressure was much lower than usual in consequence of the prolonged heat, and the deficiency increased from the Bengal coast westwards to the North-Western Provinces and the Punjab. Pressure had, on the other hand, been for some months steadily above the normal in the Deccan and Central Provinces. This combination of conditions appeared to indicate the advance of a strong monsoon up the Bay of Bengal into Northern India.

The march of the south-west monsoon current up the Bay occurred somewhat earlier than usual in the first week of June, but it failed for some time to advance further than the north of the Bay. Ships reported strong winds and heavy rain as far as the latitude of Akyab (*i.e.*, up to latitude 20° or 21° N.), and light variable winds at the head of the Bay. These peculiar conditions continued for at least a fortnight, during which period excessively hot, sultry, and oppressive weather prevailed in South Bengal. The obstruction to the advance of the current into Bengal, whatever it may have been, suddenly gave way about the 23rd of June, and the strong south-west current passed into Bengal and began to give heavy and almost continuous rain. According to the accounts of the captains of coasting steamers in the Bay (who are best able from their long experience to estimate the general strength of the monsoon), the south-west monsoon of 1888 in the Bay was not only much steadier than usual, but accompanied by a large number of severe storms and westerly gales, and the whole season was exceptionally severe and heavy in the north and north-east of the Bay. The following gives a brief list of the storms which occurred between the commencement of the monsoon and the storms under discussion.

Depression of 2nd to 5th June.—This storm formed to the north-west of the Andamans on the 2nd, and advanced in a north-west direction towards the Orissa coast, which it was approaching on the morning of the 4th. It was a storm of small intensity, and broke up on the evening of that day. It gave cyclonic winds of moderate intensity to the Burma coast on the 2nd and 3rd, but decreased in intensity as it approached the Orissa coast.

Cyclonic storm of 11th to 15th July.—This storm formed in the north-west of the Bay on the 10th and 11th, and increased rapidly in intensity. Winds of force 8 to 10 were reported by several steamers. The centre crossed the coast between Gopalpur and False Point on the evening of the 13th, and advanced in a west-north-west direction across Chutia Nagpur and Bundelkhand on the 15th. The storm broke up during the following day in East Rajputana.

Cyclonic storm of 17th to 23rd July.—Formed in the north of the Bay on the 17th and 18th almost immediately after the preceding storm broke up, and was a well-marked depression on the 19th, when the barometer at the centre was a third of an inch below the normal. The centre crossed the coast between False Point and Saugor Island, probably near Balasore, on the evening of the 19th, passed through Chutia Nagpur on the 21st, and was a little to the south of Allahabad on the 22nd. The storm partially filled up on the 23rd, but a small residual depression lay over the eastern districts of the North-Western Provinces for some days and gave heavy local rain. It finally filled up on the 27th and 28th. Winds of force 9 (Beaufort scale) were experienced at the head of the Bay during the storm. At Saugor Island a velocity of 40 miles per hour was recorded.

Cyclonic storm of 4th to 10th August.—This was a very small storm. It formed in the north-west angle of the Bay, and marched across the Orissa coast on the evening of the 8th. It advanced westwards, but gradually broke up as it crossed the Orissa hills, and died out in the eastern districts of the Central Provinces.

Depression of 19th to 21st August.—Formed in the north of the Bay, and, unlike the previous storms, advanced in a northerly direction over the Sunderbunds into Central Bengal. The centre was nearly midway between Calcutta and Dacca on the 21st. It filled up during the day in consequence of the formation of another and more extensive whirl at the head of the Bay.

Storm of 22nd to 29th August.—Formed at the head of the Bay and in South Bengal on the 21st, and increased steadily in strength on the 22nd. It gave a severe gale of wind at the head of the Bay. Seventy-two miles were recorded by the anemometer at Saugor Island between 4 and 5 A. M. of the 23rd, and winds of hurricane force (12) were experienced by several vessels at and near the Sandheads. The centre was between Calcutta and Saugor Island at 8 A. M. of the 23rd, and near Burdwan on the 24th. It drifted very slowly through West Bengal and the Sonthal Pergunnahs on the 25th and 26th, and was near Patna on the 27th. The storm passed into the eastern districts of the North-Western Provinces on the 28th, where it gradually filled up. A full account of this storm is given in the Cyclone Memoirs, Part II.

Depression of 1st to 14th September.—Weather was unsettled with frequent squalls at the head of the Bay from the 1st to the 6th September, and there was during the whole of this period a very shallow depression over the north of the Bay. It did not, however, increase in strength, and remained stationary until the 6th, when it moved westward, and crossed the Orissa coast on the afternoon of that day. It advanced on the 7th into Chutia Nagpur and the eastern districts of the North-Western Provinces, where it remained nearly stationary for the next four days, and gave excessive rain and high winds, and filled up slowly on the 11th, 12th, and 13th. The most remarkable feature of this storm was the excessive rain it gave to the Gorakhpur and Basti districts on the 10th and 11th as it was breaking up. The following were the largest amounts recorded at sub-divisional or rainfall recording stations on these days:—

District.	Station.	Amounts.	Date.
Basti	Bansi	19·60 inches.	10th.
	Domariaganj	9·40 „	10th.
Gorakhpur	Maharajganj	10·00 „	11th.

Even larger amounts appear to have fallen in some parts of these districts according to the newspaper accounts of the period. The following extract is taken from *The Pioneer*:—

> "There was an extraordinary and almost unprecedented fall of rain in the Lehra pergunna, Gorakhpur district, on Sunday and Monday (9th and 10th September) last, when about 30 inches fell in 24 hours. It is believed that all the protective and irrigation bunds on the great Lehra estate, owned by Mr. Bridgman, have been swept away. The rupture of one of these great bunds has partly destroyed the Bengal and North-Western Railway bridge over the Powa river, whilst a similar injury to another bund, some 4 miles long and from 15 to 20 feet high, erected by Mr. Bridgman to control the Gunghi and Kura streams and to protect his Sarowlie property from floods, has submerged a large area of country between Bridgmanganj and Uska Bazar, and carried away a small railway bridge, blocking all traffic on the branch line for the moment. The Post Office at Bela Haraia and many villages have been wrecked."

Weather in the Bay of Bengal from 7th to the 12th September.—This is shown fully by the following summary of the information contained in the logs of vessels received by the Meteorological Office. The index errors of the barometers used on board these vessels have been determined by comparison of their readings with those of the land observatories. The corrections applied to the actual readings to reduce them to the Calcutta standard are as follows:—

VESSEL.	Correction.	VESSEL.	Correction.
Holkar	—·11″	*Thisbe*	—·17″
Palitana	—·06	*Cutch Merchants*	—·16
Simla	—·15	*Cæsarea*	+·15 (doubtful.)
Hispania	+·10	*Phuttel Barry*	—·12 (doubtful.)
Africa	+·04	*Frankistan*	+·11
Avagyee	+·31	*County of Dumfries*	+·18
Bancoora	—·07	*City of Edinburgh*	+·16
Glenlin	—·05 (doubtful)	*Culna*	+·02
Ethiopia	*Nil*	*Mount Olivet*	—·18
Bombay	+·23	*Medea*	—·13
Ship Shah Jehan	—·07 (doubtful)	*Shahzada*	—·03
Bengal	—·09		

The barometers of the majority of the vessels appear to have been by good makers, and were, judging from the approximate constancy of the corrections found for different days, in satisfactory condition and accurately read at the time of the storm. Their corrected readings may hence be accepted as accurate to one or two hundredths of an inch. The barometers of the vessels the corrections of which are marked as doubtful appear to be less satisfactory than the others, and the errors are more or less doubtful from several causes, and probably variable from day to day. Hence the corrected readings of the barometers on board of these vessels, determined by means of the probable average error of a small number of readings, although given whenever they are not evidently wrong, are open to considerable doubt, and are only used in the charts when they are confirmed by the barometric readings taken on board of vessels named in the first column.

The following tables give abstracts of the weather information relating to the Bay for each day of the period, 7th to 12th of September, obtained from the captains of vessels navigating the Bay at the time:—

7th September.

VESSEL.	Hour.	POSITION.		BAROMETER.			WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Variation from normal.	Direction.	Force.	
		° ′	° ′						
Hispania	Noon	6—50	82—01	29·82	29·92	+·01	S.-W. to S.-E.	4	Fresh breeze and long southerly swell.
Holkar	,,	14—59	88—34	·94	·83	+·01	S.-S.-W.	3-4	
Culna	,,	16—3	97—11	·92	·94	+·09	S.-E.	2	Cloudy sky, smooth sea.
F. L. V. Meteor a	10 A.M.	20—46	87—39	·97	·82	+·07	S.-S.-E.	3	Sea slight.
F. L. V. Canopus b	,,	21—02	88—46	·99	·83	+·08	S.	3	Smooth sea, weather squally.
F. L. V. Planet c	,,	21—15	88—11	·96	·79	+·04	S.	2	Sea slight.
F. L. V. Hesperus d	,,	21—26	88—06	·96	·82	+·07	S. by W.	2	Slight swell and smooth sea.

8th September.

		° ′	° ′						
Frankistan	Noon	0—02	80—05	29·78	29·89	—·06	W.-S.-W.	6	Overcast, with rain.
Diamond	,,	Left Rangoon for Penang					N.-W.	...	Moderate winds; sky overcast.
Cæsarea	,,	6—18	81—48	29·72	29·87	—·03	W.	...	Light fleecy clouds; fine weather.
Hispania	,,	Colombo Harbour		·82	·92	+·01	S.-W.	2	Rain-squalls.
Shah Jehan	,,	11—59	85-25	·90	·84	+·01	S.-S.-W.	0	...
Cutch Merchants	,,	15—13	87—18	30·00	·84	+·02	S.	5	Sea little rough; sky clear.
Phuttel Barry	,,	16—00	87—07	29·97	·85	+·05	S.-S.-W.	...	Clear sky.
Africa	,,	Rangoon		·87	·91	+·04	S.-S.-W.	2	Cloudy, light winds.
Holkar	,,	17—11	89—7	·96	·85	+·05	S.-S.-W.	4	...

a Ridge Light. *b* Mutla Light. *c* Intermediate. *d* Lower Gasper.

8th September—continued.

VESSEL.	Hour.	POSITION.		BAROMETER.			WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Variation from normal.	Direction.	Force.	
		° ′	° ′						
Palitana . .	Noon	7—14	98—22	29·96	29·90	—·03	W.-N.-W.	4	Moderate wind; sky overcast.
Simla . . .	,,	20—36	88—33	·98	·83	+·10	S.-S.-W.	Light	Fine clear weather; smooth sea.
F. L. V. Meteor .	10 A.M.	20—46	87—39	30·00	·85	+·10	S.-W.	3	Moderate sea and fine weather.
F. L. V. Canopus .	,,	21—02	88—46	·01	·84	+·09	S.	3	Slight southerly swell.
F. L. V. Planet .	,,	21—15	88—11	29·98	·81	+·06	S.	2	Sea smooth and passing showers.
F. L. V. Hesperus .	,,	21—26	88—6	·97	·82	+·07	S. by W.	2	Slight swell.

9th September.

		° ′	° ′						
Frankistan . .	Noon	3—54	82—31	29·78	29·89	—·03	W.	6	Squally (morning); clear weather (afternoon).
Cæsarea	,,	7—33	82—27	·74	·89	—·02	S.-W.	Light.	Very fine weather.
Palitana . .	,,	10—36	97—24	·98	·92	+·01	Variable.	2	Light winds; fine weather; sea smooth.
Shah Jehan . .	,,	11—59	85—25	·90	·84	+·01	S.-S.-W.	0	...
Cutch Merchants .	,,	16—42	88—35	30·00	·84	+·02	S.-S.-W.	4	Calm sea; clear sky.
Phuttel Barry .	,,	17—30	87—33	29·97	·84	+·06	S.-S.-W.	...	Clear.
Holkar . . .	,,	18—43	89—23	·94	·83	+·05	S.-W.	3	...
F. L. V. Meteor .	10 A.M.	20—46	87—39	·99	·84	+·09	S.-W.	3	Moderate sea.
F. L. V. Canopus .	,,	21—02	88—46	·99	·82	+·07	S.	4	Slight southerly swell.
F. L. V. Planet .	,,	21—15	88—11	·98	·81	+·06	S.-S.-W.	2	Sea slight.
F. L. V. Hesperus .	,,	21—26	88—6	·95	·81	+·06	S.-S.-W.	2	Slight sea.
Simla . . .	Noon	Passing out River Hooghly		·94	·79	+·04	W.-S.-W.	Light.	Cloudy.

10th September.

Frankistan . .	Noon	6—54	84—26	29·77	29·88	—·02	W.-S.-W.	5	Pleasant breeze; cloudy but very fine weather.
Cæsarea . .	,,	8—54	82—41	·76	·91	+·03	Variable	Very light.	Fine, clear hot weather.
Shah Jehan . .	,,	11—59	85—25	·90	·84	—·01	S.-S.-W.	0	Ditto.
Palitana . .	,,	14—19	90—26	·90	·84	+·01	N.-W.	2	Light winds and fine clear weather.
Avagyee . .	,,	Off China-ba-keer lights.		·60	·91	+·06	S.-W.	...	Light winds, fine weather.
Cutch Merchants .	,,	18—1	88—00	30·00	·84	+·06	S.-S.-W.	2	Sky clear, sea calm.
Phuttel Barry .	,,	19—01	87—50	...	...	...	...	...	Clear weather.
Holkar . . .	,,	20—12	89—00	29·95	·84	+·09	S.	2-1	
F. L. V. Meteor .	10 A.M.	20—46	87—39	·98	·83	+·08	S.-W.	3	Moderate sea and fine weather.
F. L. V. Canopus .	,,	21—02	88—46	·99	·83	+·08	S.	2	Slight southerly swell.
F. L. V. Hesperus .	,,	21—26	88—06	·97	·82	+·07	S.	3	Slight swell.
F. L. V. Planet .	,,	21—15	88—11	·99	·82	+·07	S.-S.-W.	1	Sea slight.

11th September.

Vessel.	Hour.	Position.		Barometer.			Wind.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Variation from normal.	Direction.	Force.	
		° ′	° ′						
Glenlin . . .	Noon	5—24	84—54	29·95	29·90	—·02	S.-W.	6	Overcast; moderate sea.
Frankistan . .	„	9—03	85—22	·75	·86	—·02	S.-W.	Light	Cloudy; hot sultry weather. Lightning to N.-E.
Shah Jehan . .	„	11—59	85—25	·90	·84	—·01	S.-S.-W.	0	
Diamond . .	„	China-bakeer lights.		...	...	...	Variable.	2	Clear weather.
Avaygee . .	„	Tavoy river		·60	29·91	+·02	S.-W.	1	Light winds and fine throughout.
Cutch Merchants .	„	18—57	87—57	30·00	·84	+·07	S.-W.	1	Sea calm; sky clear.
Phuttel Barry .	„	19—57	87—48	...	...	...	S.-S.-W.	...	Fine weather.
Holkar . . .	„	20—56	88—43	29·95	29·84	+·09	Calm .	...	Fine weather.
F. L. V. Meteor .	10 A.M.	20—46	87—39	·99	·84	+·09	S.-W.	2	Moderate sea and fine weather.
Ethiopia . .	4 P.M.	Saugor		·80	·80	+·05	S.-W.	3	Swell from S.-S.-W., cloudy.
F. L. V. Planet .	10 A.M.	21—15	88—11	30·01	·84	+·09	W.-S.-W.	1	Sea smooth.
F. L. V. Canopus .	„	21—02	88—46	·00	·83	+·08	South .	1	Slight southerly swell.
F. L. V. Hesperus .	„	21—26	88—06	29·98	·84	+·09	Calm .	0	Very slight swell.

12th September.

		° ′	° ′						
Glenlin . . .	Noon	8—11	85—26	29·90	29·86	—·04	S.-W.	4	Overcast; heavy thunder and lightning; southerly sea.
Frankistan . .	„	10—23	85—54	·75	·86	—·02	S.-W. to W.-N.-W.	...	Fine weather; light to moderate breeze.
Avagyee . . .	„	Mergui.		·54	·85	—·04	S.-W.	0	Unsteady wind; cloudy and threatening; heavy continuous rain during afternoon and night.
Culna . . .	„	Leaving Moulmein.		·79	·83	—·03	Calm.	0 1	Fine clear weather.
Shah Jehan . .	„	15—25	86—42	·88	·82	0	W.		
Bancoora . .	„	18—54	89—52	29·88	·81	+·02	S.	2	Fine; slight southerly swell.
Ethiopia . .	„	19—23	85—22	·78	·78	+·02	W.	0	Fine clear weather; smooth sea.
Cutch Merchants .	„	19—32	87—49	30·00	·84	+·09	W.		Sea calm; sky clear during day, cloudy at night.
Phuttel Barry .	Noon.	20—12	87—38	...	...	...	Calm.	...	Clear weather.
F. L. V. Meteor .	10 A.M.	20—46	87—39	29·99	·83	+·08	Variable.	1	Moderate sea, rainy appearance.
F. L. V. Canopus .	„	21—02	88—46	30·01	·84	+·09	S.-E.	3	Light southerly swell.
F. L. V. Hesperus .	„	21—26	88—06	29·97	·82	+·07	E.	2	Smooth sea.
F. L. V. Planet .	„	21—15	88—11	30·01	·84	+·09	S.-E.	1	Heavy rain, smooth sea.

These statements, which give a brief summary of the available information, show fully the character of the weather in the Bay during the interval between the advance of the depression of the first week of September and the appearance of the storm about to be described. Fine weather, with light winds, prevailed over the whole of the Bay, except near Ceylon and over the extreme south. Skies were generally clear and sea smooth. Thus on the 10th the logs of seven vessels which were in the Bay shew that the wind on that day between Lat. 8° N. and Lat. 20° N. varied in strength from 0 to 2. On the 11th winds were even lighter and more variable than on the 10th. There were no indications of unsettled weather in any part of the Bay except in the extreme south and in the Andaman Sea, where squalls were of occasional occurrence. Thus the *Frankistan*, crossing the Equator in Long. 80° E. on the 8th, had strong west-south-west winds with heavy rain-squalls. The *Hispania* on the same day, rounding the South Ceylon coast, had a fresh south-west gale with frequent rain squalls. The *Glenlin* on the 11th, in Lat. 5° 24′ N. and Long. 84° 54′ E., had south-west winds of force 6, overcast skies, and a moderate sea. The extracts, however, plainly indicate that the weather over the entrance of the Bay was of the character usual at this time of the year, moderate to heavy squalls alternating with intervals of fine weather, during which fairly steady strong south-west to west-south-west winds prevailed. These conditions obtained as far north as Lat. 7° or 8° N., and fine clear bright weather with very light winds prevailed over the whole of the centre and north of the Bay during this antecedent period.

General character of weather in India during the antecedent period, September 7th to 12th.—It has already been stated (pages 138-139) that a small storm advanced from the Bay into the eastern districts of the North-Western Provinces during the first week of the month. It began to form in the north-west angle of the Bay, and crossed the Orissa coast on the afternoon of the 6th. On the 7th the barometer fell slightly over nearly the whole of India and rapidly in Chutia Nagpur, through which the storm was passing. During the next twenty-four hours the barometer fell over the whole of India. The fall was greatest in the eastern districts of the North-Western Provinces, to which the storm had now advanced. This general downward movement of the barometer ceased on that day, and the barometer began to rise over the whole of India except in the low-pressure area in the eastern districts of the North-Western Provinces. Excessive rain fell on the 9th and 10th in that area, as is shown by the following rainfall returns :—

DISTRICT.	AVERAGE RAINFALL OF DISTRICT ON SEPTEMBER				Total average rainfall of district during period September 7th to 10th 1888.	Heaviest fall in 24 hours in district during period.
	7th.	8th.	9th.	10th.		
Jaunpur . . .	4·66	1·13	0·52	0·10	6·41	8·10
Azamgarh . . .	0·24	3·88	2·15	1·59	7·86	7·00
Gorakhpur . . .	0·15	0·73	1·55	3·14	5·52	8·00
Basti	0·05	1·16	2·83	9·56	13·60	19·60
Benares . . .	0·85	2·14	0·14	0·21	3·34	2·50
Ghazipur . . .	0·84	3·78	1·05	0·41	6·08	5·80
Fyzabad . . .	0·17	1·89	4·36	4·13	10·55	6·64
Rai Bareili . . .	0·06	0·37	2·92	0·01	3·36	5·60
Mirzapur . . .	0·64	1·56	1·09	0·19	3·48	3·29

The depression had in fact drifted to the foot of the hills and begun to fill up on the 10th and 11th. The general increase of pressure continued on the 10th and 11th over the whole of India except in Burma, where the barometer began to fall slowly. This upward movement of the barometer accompanied a short period of fine and settled weather in Northern and Central India. The amount of cloud decreased, temperature increased, and rain fell only in local showers. On the 11th the area of lowest pressure which, during the rains, generally forms a kind of trough running east-south-east from Upper Sind or Rajputana along the southern edge of the Gangetic plain to the eastern districts of the Central Provinces and Orissa, extended as a narrow belt from the South-West Punjab in an east-south-east direction across Orissa and the north of the Bay into Burma. This eastward extension of the trough of low pressure into Burma shewed the existence of very abnormal conditions in the Bay and Burma, and already roughly indicated the line of march of the approaching cyclonic storm; for one of the most characteristic features of the cyclonic storms of the rains is their tendency to run along the trough of low or minimum pressure in existence at the time of their formation.

The charts of the 10th and 11th (*vide* Plate XIX) are given to shew the eastward extension of this trough of low pressure.

CHAPTER II.

Account of Cyclonic Storm of September 13th to 20th.

Meteorology of 12th September.—The first indications of the commencement of bad weather in Burma and the Andaman Sea were shewn on the afternoon of the 12th, and hence the history of the storm dates from that day. The following table gives the 8 A. M. observations of the 12th at stations in and around the Bay :—

STATION.	BAROMETER.			WIND.			TEMPERATURE, PRECEDING 24 HOURS.				Amount of cloud.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Port Blair	29·848	−·021	−·037	W.-N.-W.	7	78	87·8	+3·1	76·4	+0·9	7	0·10	Misty.
Nancowry	·852	−·011	−·069	W.	5	56	83·6	−3·5	72·8	−3·3	10	1·10	
Mergui	·815	−·028	−·091	N.-N.-E.	2	100	79·4	+4·1	72·4	+0·2	10	1·10	
Tavoy	·795	−·036	?	Calm.	2	?	86·2	?	75·2	?	7	0·07	
Moulmein	·821	−·038	−·037	N.-E.	3	100	90·9	+7·7	75·5	+1·8	0	0·16	
Rangoon	·852	−·005	−·001	N.-N.-E.	4	100	89·0	+3·9	75·4	−0·2	1	...	
Bassein	·839	−·001	+·011	Calm.	3	100	90·7	+6·6	77·3	+2·1	5	1·53	
Diamond Island	·837	−·004	−·023	N.-W.	4	57	84·4	+1·2	75·5	+1·8	4		Fine.
Akyab	·848	−·022	+·047	N.-W.	2	67	83·2	−4·3	79·1	+0·9	5	0·03	Fine.
Chittagong	·858	−·022	+·055	N.-E.	2	33	88·1	+0·2	74·0	−3·0	9	1·50	Rainy.
Saugor Island	·816	−·033	+·082	E.-N.-E.	9	90	89·2	+0·2	81·0	+1·9	8	0·02	Sea smooth.
False Point	·814	−·016	+·087	Calm.	8	100	89·0	+0·4	79·7	+1·6	7	...	Fine.
Vizagapatam	·826	−·026	+ 082	W.	0	0	88·9	+2·3	81·1	?	3	...	Fine.
Masulipatam	·839	−·020	+·052	W.-N.-W.	2	33	92·6	+0·6	75·6	−1·7	2	...	Fine.
Madras	·845	−·030	−·010	N.-W.	5	83	89·9	−4·3	74·4	−2·5	2	...	Fine.

As already stated, the general rise of the barometer on the 8th, 9th and 10th over India due to general actions ceased, and was followed by the return downward movement which began on the afternoon of the 11th.

The following table gives the average pressure variations from the normal in different parts of India on the 12th :—

Lower Burma	·02" above.
Bengal	·08" „
North-Western Provinces	·08" „
Punjab	·07" „
Central Provinces	·06" „
Madras	·03" „

It has been already stated that a more or less complete break in the rains obtained in Northern and Central India. As usually happens during such periods, pressure was above the average over the whole of India, and the excess was greater in Upper than in Central India. The chief effect of these pressure variations was to give approximately uniform pressure over by far the greater part of Northern and Central India.

The only important and prominent feature of the pressure distribution on the morning of the 12th was the belt of low pressure which stretched in an east-south-east direction from the West Punjab across the head of the Bay into Lower Burma. This feature is shewn very clearly on the chart of the day, where it is defined by the isobar of 29·85. The following statement gives pressure in four lines or sections running across this trough. It not only illustrates this feature, but shews roughly the very slight differences of pressure over Northern India and indicates the general position of the axis of the trough :—

First Section.		Second Section.	
Station.	8 A. M. Pressure. Reduced to sea-level.	Station.	8 A. M. Pressure. Reduced to sea-level.
	Inches.		Inches.
(*a*) Port Blair	29·848	(*b*) Madras	29·845
Diamond Island	·837	Vizagapatam	·826
Chittagong	·858	False Point	·814
Silchar	·855	Calcutta	·816
		Berhampore	·838
		Dhubri	·841

Third Section.		Fourth Section.	
Station.	8 A. M. Pressure. Reduced to sea-level.	Station.	8 A. M. Pressure. Reduced to sea-level.
	Inches.		Inches.
(*c*) Gorakhpur	29·788	(*d*) Neemuch	29·889
Allahabad	·765	Jeypore	·836
Sutna	·795	Agra	·815
Jubbulpore	·828	Meerut	·795
Seoni	·807	Roorkee	·816
Nagpur	·808		
Secunderabad	·889		

These figures establish conclusively the existence of a long narrow area of low pressure stretching in a curved line through Meerut, Nagpur, False Point, and Diamond Island across Lower Pegu. The third section shews two positions of minimum pressure, *viz.*, at Nagpur and Seoni in the Central Provinces and at Allahabad. The latter was, however, due to the small depression and cyclonic storm of the 1st to 14th of September, which was now in the eastern districts of the North-Western Provinces and had not yet quite filled up.

The preceding remarks have shewn that the following were the more prominent meteorological conditions immediately before the arrival of the storm in the Indian area on the evening of the 12th and morning of the 13th :—

(1) Approximate uniformity of pressure, such as usually accompanies a break in the rains in September, over the northern half of the Bay and the greater part of Northern and Central India.

(2) Peculiar pressure conditions in Lower Burma and the north of the Bay, the result of which was the extension of the trough of low pressure,

which usually stretches in the beginning of September from Sind to Orissa, across the north of the Bay into Lower Burma.

(3) The prevalence in India and the Bay of Bengal of the weather conditions which usually accompany a break in the rains (*viz.*, increasing temperature, decreasing humidity, local land winds in the interior of India and rapidly decreasing rainfall).

September 13th.—The following two tables give the 8 A. M. and 4 P. M. observations of the 13th taken at the observing stations in Burma, and at a few other representative stations in India:—

8 A. M. observations.

STATION.	BAROMETER.			WIND.			TEMPERATURE, PRECEDING 24 HOURS.				Amount of cloud.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Mergui . .	29·694	−·121	−·212	S.-S.-W.	3	150	79·2	−4·3	70·5	−1·7	10	5·25	
Tavoy . .	·643	−·152	?	N.-W.	3	?	87·2	?	74·2	?	8	1·83	
Moulmein .	·692	−·129	−·166	N.	5	167	90·9	+7·7	74·5	+0·8	2	0·22	Fine.
Rangoon .	·721	−·131	−·132	N.-N.-W.	3	75	91·0	+5·9	73·9	−1·7	10	0·86	Showery.
Bassein . .	·769	−·070	−·059	Calm	6	200	90·2	+6·1	74·8	−0·4	10	1·20	
Diamond Island.	·796	−·041	−·064	N.	6	86	86·4	+3·2	74·0	+0·3	10	0·64	Thunderstorm.
Port Blair .	·796	−·052	−·089	W.-S.-W.	8	89	85·0	+0·3	75·9	+0·4	7	1·70	Drizzling.
Toungoo .	·737	−·095	−·098	N.-N.-W.	2	67	94·2	+5·6	77·7	+2·3	10	...	
Thayetmyo .	·772	−·074	−·059	N.-W.	6	120	93·8	+3·5	76·9	+1·5	5	...	
Calcutta .	·808	−·008	+·055	Calm	1	20	88·5	−0·1	77·2	−1·1	8	1·48	
Madras . .	·820	−·025	−·033	W.	5	71	93·5	−0·7	77·5	+0·6	0	...	Clear.
Negapatam .	·828	−·050	−·020	S.-W.	5	100	92·5	+0·1	77·2	+1·3	5	...	Fine.
Bombay .	·886	−·021	+·009	N.-E.	9	75	85·9	+1·6	76·0	+0·3	10	0·11	
Allahabad .	·781	+·016	+·052	N.-N.-E.	2	67	91·2	−0·3	76·6	−0·5	8	0·29	Fine.
Lahore . .	·722	−·048	+·030	S.-E.	2	100	103·1	+4·9	71·9	−4·0	0	...	

4 P. M. observations.

STATION.	BAROMETER.			WIND.			Amount of cloud.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Mergui	29·635	−·053	−·167	S.	3	150	10	
Moulmein . . .	·554	−·112	−·184	N.	13	433	6	
Rangoon	·547	−·131	−·196	N.-N.-E.	10	250	8	
Bassein	·572	−·127	−·167	N.-W.	11	367	8	
Diamond Island . .	·602	−·109	−·157	N.-W.	9	129	8	
Port Blair . . .	·670	−·080	−·116	W.-N.-W.	8	89	9	Drizzling.
Toungoo	·601	−·069	−·115	N.	7	233	10	
Thayetmyo . . .	·597	−·094	−·081	N.	13	260	5	Passing showers.
Calcutta	·653	−·055	+·005	N.-N.-E.	2	40	5	Drizzling.
Madras	·690	−·047	−·032	S.-S.-W.	5	71	2	Thunder and lightning.
Negapatam . . .	·714	−·041	−·028	S.	7	140	4	
Bombay	·751	−·042	−·018	W.-N.-W.	12	100	8	
Allahabad . . .	·681	+·013	+·047	N.-W.	3	100	10	Thunder.
Lahore	·602	−·019	+·016	W.	1	50	0	Clear.

The meteorological information relating to the sea area, contributed by ships, is given in the following two tables. The first table gives the observations taken in the Andaman Sea, and the second the observations taken in the Bay of Bengal. In the case of the former the whole of the information obtained is tabulated.

Observations taken in the Andaman Sea on the 13th September.

VESSEL.	Hour.	POSITION.		BAROMETER.			WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
		° ′	° ′						
Avagyee	2 A. M.	...	...	29·40	29·71	...	E.	...	Violent squalls from east.
	5 "	...	...	·29	·60	—·25	S.-E.	...	Heavy rain.
	6 "	In Tenasserim river near Mergui.		·30	·61	...	S.-S.-W.	...	Barometer falling rapidly.
	Noon	...	...	·43	·74	—·15	S.-S.-W.	...	8 A. M. Wind moderate and very unsteady; squalls taking off.
	Midnight.	...	...	·54	·85	...	Unsteady	...	Wind unsteady with frequent rain squalls.
Bancoora	4 A. M.	...	...	·83	·76	...	Calm	0	
	8 "	...	...	·86	·79	—·04	N.-N.-E.	2	
	Noon	16—07	92—04	·86	·79	—·03	S.-E.	4	Dull weather. Heavy masses of pallio-cumulus with rain.
	4 P. M.	...	...	·72	·65	...	W.-N.-W.	2	
	8 "	...	...	·74	·67	...	W.	4	
	Midnight.	...	...	·74	·67	...	S.-W.	2	
Mount Olivet	8 A. M.	Left Rangoon at noon.		...	...	...	N.-W.	3	Very heavy squalls, thunder, lightning and much rain.
	Midnight.	...	...	...	...	...	W.-N.-W.	5	Squally with heavy rain.
Africa	Noon	Rangoon river.		29·53?	...	...	...	...	Cloudy weather, wind changeable, showers.
Diamond	Noon	Mouth of Rangoon river.		...	...	...	N.	...	Northerly wind and clear weather.
	6 P. M.	...	...	...	...	...	W.	...	Wind hauled to west, sea rising. Much rain.
	Midnight.	...	...	...	...	...	S.-W.	...	Strong gale with squalls and heavy rain.
Culna	4 A. M.	...	...	·70	·72	...	N.-W.	2	Cloudy and light winds.
	8 "	...	...	·75	·77	—·04	N.-W.	1	Unsteady winds, heavy rain and smooth sea.
	Noon	16—40	93—4	·70	·72	—·05	N.-W.	3	Moderate winds and overcast.
	4 P. M.	...	...	·63	·65	...	N.-W.	3	Ditto ditto.
	8 "	...	...	·66	·68	...	N.-W.	5	Fresh wind, and fine cloudy weather.
	Midnight.	...	...	·66	·68	...	N.-W. by N.	6	Strong winds and heavy rain; very thick weather.

Observations taken in the Bay of Bengal.

VESSEL.	Hour.	POSITION.		BAROMETER.			WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
		° ′	° ′						
Glenlin . .	Noon	10—37	85—53	29·87	29·82	—·04	W.	4	Heavy overcast sky with occasional showers.
Bengal . .	8 A. M.	...	...	·92	·83	—·04	W.-S.-W.	3	Moderate breeze and cloudy.
	Noon	11—43	84—11	·92	·83	—·02	W.-S.-W.	3	
Frankistan . .	8 A. M.	...	...	...	...	...	W.-N.-W.	...	Moderate breeze and showery; squally with heavy rain at night.
	Noon	12—06	86—40	·70	·81	—·05	W.-N.-W.	...	
Cæsarea . .	Noon	13—42	83—52	·72	·84	+·01	S.-W	Light	Very fine weather, sea smooth.
Shah Jehan . .	Noon	16—22	86—44	·88	·81	+·01	W.	...	Light airs and calms.
Cutch Merchants .	Noon	19—41	87—45	·90	·74?	—·01?	Calm	...	Sky clear, smooth sea.
Phuttel Barry .	,,	20—36	87—49	·90	·78	+·05	Calm	...	
F. L. V. Planet .	10 A. M.	21—15	88—11	·98	·81	+·06	Calm	0	Sea smooth.
F. L. V. Meteor .	,,	20—46	87—39	·96	·81	+·06	Variable	1	Light southerly swell.
F. L. V. Hesperus .	,,	21—26	88—06	·96	·81	+·06	Calm	0	Smooth sea.
F. L. V. Canopus .	,,	21—02	88—46	·98	·81	+·06	Calm	0	Slight southerly swell.
City of Edinburgh	1-50 P. M.	Off Saugor		...	...	...	S.-W.	1	Light airs and clear, slight swell from south.

The observations of the 13th September are important as they give the first marked indication of the existence of the cyclonic storm. A rapid fall of the barometer occurred in the early morning of the 13th on the Tenasserim coast. The fall during the previous 24 hours at Mergui was ·12″, at Tavoy ·15″, at Rangoon and Moulmein ·13″, and at Diamond Island ·04″. The wind began to increase in force at Rangoon about midnight and was blowing a gale at 4 A.M. Rain commenced at 6 A.M., and the wind fell off for some hours but increased steadily during the afternoon and evening. The temporary very squally weather in the early morning is somewhat difficult to explain. It is, however, confirmed by the weather as experienced at Mergui on board the *Avagyee.* Her log states that the barometer fell rapidly in the early morning up to 5 A.M., and that during that interval weather was very squally. It was showery, with light to moderate unsteady winds during the remainder of the day.

The large fall of the barometer at the eastern stations in Burma as compared with that at Diamond Island indicates clearly that the depression was to the east of Rangoon, Moulmein, Tavoy and Mergui in the morning. The wind directions, too, shew equally clearly that the storm had not formed in the Andaman Sea. They exhibit much irregularity, such as, in fact, is known to occur either when a cyclonic storm is being generated, or when it has formed and is crossing over broken and hilly ground; but indicate generally that they were part of a cyclonic circulation over an area of depression the centre of which was to the east of Moulmein and Tavoy and thus confirm the inferences drawn from the barometric changes. Hence it is almost certain that the irregularity in the winds was due to the fact that the storm was passing across the Tenasserim hills. The character of the disturbance at this time is shewn even more clearly by the weather experienced by ships in the Gulf of Martaban and Andaman Sea. Thus the *Avagyee* at Mergui had violent squalls from the east at 2 A.M., and from south-east at 5 A.M. These wind directions (if correctly given), cannot be explained by a well defined cyclonic storm crossing the Tenasserim hills in about Lat. 15°N., and were probably due to a small temporary local disturbance. It is of course possible (but not probable), that the wind directions were the exact opposite of those given—a mistake occasionally made in stating wind directions. The *Bancoora,* which passed through the Preparis Channel into the Andaman Sea during the afternoon, had a calm at 4 A.M., north-north-east winds at 8 A.M., south-east winds (force 4) at noon in Lat. 16° and Long. 92° and west-north-west winds (force 2) at 4 P.M. These rapid changes of wind direction and force cannot be explained by the assumption that the vessel was approaching a fully-formed cyclonic storm, and are remarkable as shewing the irregularity of the air motion in the outskirts of the depression. The steamers *Mount Olivet, Diamond* and *Africa* left Rangoon in the morning. The first-named steamer had north-west winds, squalls, heavy rain, thunder and lightning, and the *Africa,* cloudy and changeable weather with occasional showers. The *Diamond,* which left for Penang at 8 A.M., passed out of the river at noon, and had northerly winds and clear weather at that time. At 6 P.M., when she was in about latitude 15°N., the wind shifted to west, the sea began to rise, and rain to fall. At midnight it was blowing a strong gale from the south-west, with heavy squalls and rain. The change of wind in this case indicated that the storm was to the east and south-east of Rangoon and Moulmein, and that it was advancing westwards across Tenasserim and the Gulf of Martaban and not northwards up the Andaman Sea.

The observations, taken as a whole, hence establish that there was a disturbance and storm crossing the Tenasserim hills to the east and south-east of Moulmein and Tavoy on the morning of the 13th. There was, as usually occurs when a storm is crossing hilly country, much irregularity in the cyclonic motion of the air, more especially in front of the advancing storm, and there was a marked tendency towards the formation of separate eddies (*e.g.*, at Mergui and Rangoon) on the early morning of the 13th. The disturbance had fully crossed the Tenasserim hills before the evening of the 13th and thence passed into the North Andaman Sea and Gulf of Martaban. The weather hence became rapidly worse in Lower Burma and the Andaman Sea during the afternoon and evening, and at midnight a strong south-westerly gale was blowing over a considerable portion of the sea area and feeding into the storm, and the winds in Lower Burma and the Andaman Sea recorded at 4 P.M. (*vide* Chart, Plate XXI) show that a well-developed cyclonic circulation was established over the area of depression which now covered Tenasserim, Lower Burma and the North Andaman Sea. The centre at midnight was probably a little to the west of Moulmein.

The weather in the Bay of Bengal is shewn fully by the observations of a large number of vessels. It was squally over the Bay to the south of Lat. 12° N. Thus the *Glenlin* in Lat. 10½° N. at noon had overcast skies, the *Bengal* in Lat. 11½° N. had rain-squalls, and the *Frankistan* in Lat. 12°N. squalls with heavy rain. Further north, in the centre of the Bay, the ships *Shah Jehan*, *Cutch Merchants* and *Phuttel Barry* had calms and very light winds. At the head of the Bay the weather as experienced by the *Ethiopia*, the *City of Edinburgh*, and the light-vessels at the entrance to the Hughli was fine and clear, with calms or light south-west breezes (force 1 to 2). The only important feature in the meteorology of India on this day (in addition to the depression and storm advancing across Tenasserim into Lower Burma) was the trough of low pressure stretching from Upper Sind in an east-south-east direction and terminating in the deep depression overlying Tenasserim. It is clearly shown in the charts of the day (Plates XX and XXI). The following tables, giving the pressures along four lines of stations running across this trough or belt of low pressure, shew its position very clearly, and also that the slight depression in the eastern districts of the North-Western Provinces (indicated previously by the low barometer at Allahabad in the third section) had almost disappeared:—

FIRST SECTION.		SECOND SECTION.	
Station.	8 A. M. Pressure. Reduced to sea-level.	Station.	8 A. M. Pressure. Reduced to sea-level.
	Inches.		Inches.
(*a*) Port Blair	29·796	(*b*) Masulipatam	29·797
Diamond Island	·796	Vizagapatam	·793
Akyab	·787	Gopalpur	·785
Chittagong	·801	False Point	·808
		Saugor Island	·805
		Calcutta	·808
		Berhampore	·805

THIRD SECTION.		FOURTH SECTION.	
Station.	8 A. M. Pressure. Reduced to sea-level.	Station.	8 A. M. Pressure. Reduced to sea-level.
	Inches.		Inches.
(*c*) Secunderabad	29·849	(*d*) Neemuch	29·803
Nagpur	·782	Jeypore	·807
Seoni	·779	Agra	·793
Jubbulpore	·795	Delhi	·778
Allahabad	·781	Meerut	·778
Gorakhpur	·814	Roorkee	·799

The line of lowest pressure hence ran through Akyab, Gopalpur, Seoni, Nagpur, Delhi and Meerut.

September 14th.—The following gives the 8 A.M. observations at selected stations in and near the storm area:—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PAST 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Port Blair . .	29·787	−·009	−·093	W.-N.-W.	11	122	81·0	−4·1	74·9	−1·4	10	5·00	Drizzling; squally.
Mergui . .	·836	+·141	−·088	S.	3	150	80·2	−4·0	70·4	−2·1	10	1·04	
Tavoy . .	·784	+·141	?	Calm.	5	?	82·2	?	74·7	?	10	2·75	
Moulmein . .	·767	+·075	−·108	S.-E.	8	267	87·8	+4·4	75·5	+1·6	9	0·03	
Rangoon . .	·671	−·050	−·164	E.-S.-E.	13	325	90·0	+4·7	75·4	−0·1	10	1·35	Raining.
Bassein . .	·570	−·199	−·224	S.-E.	10	333	88·7	+4·2	75·3	+0·1	10	2·14	
Diamond Island .	·567	−·229	−·257	W.-S.-W.	8	114	87·4	+4·7	68·1	−6·5	10	3·58	Sea smooth.
Akyab . .	·695	−·092	−·113	E.	5	167	91·2	+3·7	80·1	+1·9	10	0·12	
Chittagong .	·688	−·113	−·083	Calm.	1	25	91·7	+3·8	79·0	+2·0	3	—	Squally.
Calcutta . .	·720	−·088	−·035	N.-N.-E.	1	20	86·0	−2·2	78·7	+0·3	0	0·74	
Saugor Island .	·722	−·083	−·012	N.-W.	7	70	88·7	−0·3	82·0	+2·9	7	0·07	Sea smooth
False Point .	·729	−·079	−·010	W.-N.-W.	4	50	89·5	+0·9	76·6	−1·5	8	—	
Gopalpur .	·728	−·057	−·040	N.-W.	13	186	89·7	+1·9	81·8	+1·1	3	—	Sea smooth.
Vizagapatam .	·759	−·034	−·035	W.	0	0	88·9	+2·3	81·1	−2·1	7	—	Fine.
Secunderabad .	·791	−·058	−·043	W.-N.-W.	6	86	94·1	+9·1	73·4	+3·9	2	—	Fine.
Chikalda . .	26·249	−·031	−·001	N.	?	?	79·6	+5·8	66·4	+2·4	9	—	
Nagpur . .	29·759	−·023	0	N.-W.	6	120	97·2	+9·0	76·0	+2·5	10	0·03	
Seoni . .	·727	−·052	−·019	Calm.	5	125	89·2	+4·3	74·1	+3·3	5	0·41	Distant lightning.
Jubbulpore .	·765	−·030	−·010	Calm.	2	67	87·9	+1·0	74·1	+1·3	8	—	Fine.
Allahabad .	·759	−·022	+·011	Calm.	2	67	92·2	+1·3	77·1	+0·3	9	0·02	Thunderstorm.

The general changes over the Indian area were at this time small. Pressure continued to diminish steadily, but the relative distribution remained unchanged over the whole of Northern and North-Western India. A rapid fall of the barometer had occurred at Bassein and Diamond Island and a somewhat smaller rise at the Tenasserim stations. The barometer fell briskly in the north of the Bay, Aracan, Assam, and Bengal. These local changes were due in part to the west-north-west motion of the cyclonic storm which entered and crossed the Gulf of Martaban from Tenasserim on the previous evening and night. Over the whole of India, except Burma, light local unsteady winds were blowing. Skies were clear in the Punjab, but were more or less clouded in all other districts and were overcast in Lower Burma and the Malabar Coast. Moderately heavy rain was falling in Burma. Little or none was falling in other districts.

The observations of the Lower Burma stations prove that the storm centre had advanced across the Gulf of Martaban into South-west Pegu. The barometer had fallen ·2″ at Bassein and ·23″ at Diamond Island, and was now rising rapidly at Moulmein. The winds were cyclonic in strength and direction and indicated that the centre was to the south-west of Bassein and probably nearly midway between Bassein and Diamond Island. It was hence crossing the Bassein hills. These hills are comparatively low, nowhere reaching 2,000 feet in altitude. Very strong winds had prevailed for some hours previously in Lower Burma. The average velocity at Rangoon during the previous 24 hours, for example, was 13 miles per hour, and the actual velocity at 8 A.M. was 34 miles per hour. The winds in the south-west quadrant of the storm were feeble, and were not of excessive violence in the north-east and south-east quadrants except during the squalls. At Diamond Island the wind velocity of the previous 24 hours only averaged 8 miles per hour. At 8 A.M. it was only 10 miles, and the sea was smooth. The observations hence indicate that the storm was of moderate intensity and extent, and that it was fed at this time chiefly by indraught from the Andaman Sea. The barometer at the centre was probably not below 29·5″, and the depression about three-tenths of an inch.

The following gives the average rainfall of the previous 24 hours in each of the larger provinces of India:—

PROVINCE.	Average rainfall of 24 hours ending 6 P.M., 13th September.	Normal average daily rainfall, September.
	Inch.	Inch.
Burma . . .	0·38	0·57
Bengal . . .	0·03	0·29
Assam . . .	0·02	0·30
Central Provinces .	0·36	0·31
N.-W. Provinces .	0·03	0·26
Punjab . . .	0	0·06
Rajputana . .	0	0·06
Central India . .	0·16	0·24
Bombay . .	0·32	0·25
Madras . . .	0·22	0·12

The following gives the 4 P. M. observations at selected stations:—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Port Blair	29·691	+·021	—·090	W.	10	111	9	Misty.
Mergui	·764	+·128	—·056	S.	3	150	10	
Thayetmyo	·630	+·030	—·066	S -W.	5	100	8	Passing showers.
Moulmein	·690	+·135	—·077	S.-W.	10	333	9	
Rangoon	·613	+·066	—·151	S.-E.	11	275	8	
Bassein	·553	—·020	—·164	S.-E.	20	667	10	

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Diamond Island . . .	29·560	—·042	—·191	S.-W.	10	143	10	Threatening.
Toungoo	·632	+·029	—·093	S.-E.	3	100	10	Raining.
Akyab	·620	+·010	—·080	E.-N.-E.	6	200	10	
Chittagong . . .	·594	—·045	—·084	S -S.-W.	3	75	7	
Calcutta	·589	—·064	—·057	N.	3	60	8	
Saugor Island . . .	·600	—·050	—·030	N.-W.	13	130	9	
False Point . . .	·619	—·043	—·019	E.-N-E.	6	75	10	
Gopalpur . . .	·622	—·043	—·043	S.-E.	8	114	3	Clear.
Vizagapatam . . .	·589	—·062	—·054	S.-S.-E.	1	25	4	Do.
Secunderabad . . .	·635	—·018	—·040	N.-W.	11	157	5	
Chikalda	26·125	—·027	—·018	N.	?	?	9	
Nagpur	29·654	+·023	—·009	N.-N.-W.	14	280	9	
Seoni	·672	+·007	—·010	N.-N.-W.	7	175	6	
Jubbulpore . . .	·691	—·007	+·012	S.-W.	2	67	8	
Allahabad	·639	—·042	—·010	N.	2	67	9	Thunder-storm.

These observations show that the storm centre had passed out into the Bay of Bengal and was to the west-north-west of Diamond Island. Very strong south-east winds were blowing at Bassein, but the effect of the hills in diminishing the strength of the circulation continued to be shown by the Diamond Island wind observations. Moderate south-west winds (average velocity 10 miles per hour) were blowing at that station. Along the north-west coast of the Bay winds were light and unsteady, but had shifted round during the previous night to directions ranging between west and north, thus proving that the cyclonic circulation had extended westwards as far as the north-west coast of the Bay.

The table below gives the meteorological observations taken on board ships in the Andaman Sea and the Bay of Bengal on the 14th:—

VESSEL.	POSITION.			BAROMETER.			WIND.		Weather.
	Hour.	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
		° ′	° ′						
Africa .	8 A.M.	...	...	29·70	29·74	—·12	E.	6	Showers during the morning.
	Noon	Rangoon river		·75	·79	—·05	S.-E.	6	
	Midnight	...	...	·73	·77	...	S. by E.	4	
Diamond . .	Noon	13—1	96—55	...	...	...	S.-W.	Gale	Strong gale with heavy squalls and much rain; very high sea.
Bancoora .	8 A.M.	...	...	·78	·71	—·17	W.-S.-W.	4	
	Noon	13—00	94—20	·85	·78	—·08	W.-S.-W.	4	Thick rainy weather, with moderate south-westerly swell.
	4 P.M.	...	...	·78	·71	...	S.-W.	4	
	Midnight	...	...	·90	·83	...	S.-W.	4	

VESSEL.	POSITION.			BAROMETER.			WIND.		Weather.
	Hour.	Latitude, North.	Longitude, East.	Actual.	Corrected.	Variation from normal.	Direction.	Force.	
		° ′	° ′						
Mount Olivet	8 A.M.	...	...	29·88	29·70	—·17	W.-S.-W.	5	Drizzling rain.
	Noon	13—57	93—00	·92	·74	—·11	...	...	
	4 P.M.	...	...	·80	·62	...	...	...	
	Midnight	...	...	·87	·69	...	S.-W.	7 to 8	Strong monsoon with hard squalls and high seas.
Avagyee . .	Noon	Proceed Mergui t	ing from o Tavoy.	·54	·85?	—·02?	E.-N.-E. to S.-S.-E.	...	Light unsteady winds with frequent rain-squalls.
County of Dumfries.	Noon.	1—17 S.	84—21	·72	·90	?	West and S.-W.	1	Light airs with occasional squalls.
Thisbe . .	Noon	7—18	82 - 09	30·04	·87	—·04	Variable.	3	Clear.
Bombay .	8 A.M.	...	...	29·60	·83	—·06	...	...	Moderate breeze and cloudy; slight sea.
	Noon	10—16	83—51	...	...	...	...	...	
Glenlin . .	Noon	12—45	86—20	·80	·75	—·09	W.	4	Winds variable from N.-W. to S.-W. with heavy thunder-squalls. Lightning very vivid.
Frankistan . .	Noon	13—56	87—57	·64	·75	—·08	W.-N.-W.	4	Fine clear weather.
Cæsarea . .	Noon	14—34	84—47	·66	·76?	—·07?	S.-W.	...	Very fine weather; smooth sea.
Bengal . .	Noon	16—07	86—18	·86	·77	—·03	W.-N.-W.	2	Light winds, cloudy weather and light showers.
S[illegible] Snon Jehan.	8 A.M.	...	...	·60	·53	—·16	N.-N.-W.	..	Rainy.
	Noon	17—3	87·—3	(?)	(?)				
City of Edinburgh	Noon	17—48	86 —29	·56	·71	—·06	S.-W.	4	Squally, southerly swell.
Culna . .	4 A.M.	...	...	·65	·67	...	N. to N.-N.-W.	6	Severe squalls, heavy rain.
	8 „	...	...	·66	·68	—·16	N.-W. and W.	1	Dark gloomy weather; confused sea.
	Noon	18—59	90—10	·69	·71	—·11	N.-N.-W.	6	Strong wind, overcast, and rain.
	4 P.M.	...	...	·60	·62	...	N.-W. by N.	2	Sky clear and moderate sea.
	8. „	...	...	·65	·67	...	Northerly	4	Sky cloudy and moderate sea.
	Midnight	...	...	·69	·71	...	Northerly	4	Ditto ditto.
Medea . .	Noon	19—12	86—24	·84	·71	—·05	W.	2	Clear during day, cloudy at night.
Cutch Merchants	Noon	19—52	88—06	·87	·71	—·04	N.-W.	3	Sky clear and smooth sea.
Phuttel Barry .	Noon	20—36	87—43	·90	?	?	Variable.	...	Sea smooth; hazy.
F. L. V. Meteor .	10 A.M.	20—46	87—39	·88	·72	—·03	N.-W.	2	Light southerly swell.
F. L. V. Canopus	„	21—02	88—46	·90	·73	—·02	N.	3	Very heavy lightning from north round to east during the night.
F. L. V. Hesperus	„	21—26	88—6	·88	·73	—·02	N.-W.	1	Smooth sea.
F. L. V. Planet .	„	21—15	88—11	·90	·73	—·02	N.	1	Sea slight.

The meteorological observations taken in the Bay of Bengal and Andaman Sea on this day do not contribute much to our knowledge of the storm, as not one of the vessels which furnished logs was within the storm area during the day. In the south-west and west of the Bay of Bengal fine weather with light, and in some cases variable, winds generally prevailed. One vessel, the *Glenlin*, in Lat. 12° 45′ N., and Long. 86° 20′ E., experienced squalls, but even in her case the winds were variable. The force of the winds in the part of the Bay outside of the storm area ranged from 1 to 4.

The weather was, on the other hand, stormy over the centre and north of the Andaman Sea. The ***Mount Olivet*** to the east of the Andamans had strong monsoon winds (force 7 to 8) with hard squalls. The ***Diamond***, 270 miles further to the east, experienced a strong gale with heavy squalls. The ***Culna***, proceeding to Calcutta from Moulmein, was in front of the storm during the day at an average distance of about 200 miles from the centre. She had strong winds during the greater part of the day.

The whole of the evidence hence shows that the cyclonic circulation was of very different strength and intensity in different quadrants of the storm area, and that strong cyclonic winds prevailed in the southern and eastern quadrants, indicating a very strong indraught from the Andaman Sea. Winds were comparatively light, unsteady, and variable in the western and northern quadrants during the morning and afternoon. This was evidently due chiefly to the fact that the circulation in this portion of the storm area in the Bay of Bengal was still partially interfered with and broken up by the obstruction offered by the Bassein hills. The storm was of moderate intensity when it passed out into the Bay of Bengal in the morning, but the increase in the force of the winds experienced during the evening by one or two vessels just outside of the storm area, was almost certainly due to its extension as well as to the increasing intensity of the storm.

September 15th.—The following table gives the 8 A. M. observations at the coast stations of the Bay, and at a few selected stations in India:—

STATION.	BAROMETER.			WIND.			TEMPERATURE PAST 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Port Blair	29·832	+·045	—·063	W.-S.-W.	9	100	80·4	—5·5	73·9	—2·5	9	1·25	Misty.
Mergui	·889	+·050	—·031	S.	1	50	81·2	—2·1	69·9	—2·6	10	3·20	
Tavoy	·852	+·068	?	Calm.	5	?	83·2	?	74·2	?	10	0·82	
Moulmein	·861	+·094	—·020	S.-E.	6	200	88·8	+4·8	76·5	+2·3	4	...	
Rangoon	·818	+·147	—·044	E.	7	175	79·1	—5·4	76·4	+0·4	9	1·41	Showery.
Thayetmyo	·803	+·008	—·045	S.-S.-E.	5	100	88·8	—0·4	75·9	—0·4	8	0·02	
Toungoo	·767	+·006	—·029	S.	2	67	87·3	—0·1	76·2	+1·1	8	0·89	
Bassein	·770	+·200	—·060	S.-E.	15	500	83·2	—1·1	74·8	—0·4	10	1·68	Showery.
Diamond Island	·765	+·198	—·097	S.	14	200	82·4	—0·7	72·0	—3·1	6	1·67	Sea rough.
Akyab	·697	+·002	—·106	S.-E.	6	200	87·2	+1·5	80·6	+2·6	10	...	
Chittagong	·698	+·010	—·092	E.	2	50	89·6	+2·1	77·0	+0·5	9	0·61	Drizzling
Saugor Island	·677	—·045	—·072	N.-N.-W.	9	90	90·7	+3·0	81·5	+2·2	10	0·02	
Calcutta	·676	—·044	—·061	Calm.	2	40	91·0	+2·8	80·7	+2·1	10	0·04	
False Point	·667	—·062	—·063	N.-N.-E.	5	63	89·0	+1·1	76·6	—1·3	10	0·27	
Gopalpur	·691	—·037	—·066	N.-W.	7	100	89·7	+2·1	80·8	+0·3	4	...	Sea slight.
Vizagapatam	·692	—·067	—·063	N.	0	0	87·9	+1·0	82·6	?	6	...	Fine.
Cocanada	·682	—·058	?	W.-S.-W.	4	?	91·0	?	79·1	?	8	...	Sea smooth.
Secunderabad	·758	—·033	—·065	W.-N.-W.	7	100	93·6	+10·3	71·9	+2·0	1	...	Fine.
Nagpur	·732	—·027	—·030	N.-N.-W.	7	140	80·7	—7·0	73·6	+0·3	5	0·18	
Chanda	·737	—·021	—·042	N.-N.-W.	3	75	89·0	+0·4	74·2	+0·1	6	...	
Seoni	·738	+·011	—·021	W.	4	100	82·1	—2·7	71·1	+0·5	5	0·15	Distant lightning.
Jubbulpore	·756	—·009	—·009	E.-N.-E.	1	33	85·9	—1·5	71·6	—1·8	10	0·28	
Chyebassa	·695	—·031	?	Calm.	1	?	90·9	?	77·7	?	8	...	
Hazaribagh	·727	—·020	—·014	E.-N.-E.	4	57	85·9	+0·8	73·1	+0·4	3	...	Fine.

The barometer fell during the previous 24 hours over the whole of India. The changes were small, except in the north of the Bay and the adjacent coast districts, where they were due to the advance of the depression in a west-north-west direction from the West Pegu coast towards the coast of Orissa. The barometer was rising very rapidly in Lower Burma, and had fallen briskly on the Ganjam, Orissa, and Bengal coasts. The general cyclonic circulation, of which the storm formed the central part, now included the whole of the Bay and the adjacent coast districts. Strong south-west winds were blowing at Port Blair and south winds at Diamond Island, and very strong south-east winds at Bassein, but to the north and west of the central depression, as shown by the observations at Chittagong, Saugor Island, Calcutta, and False Point, the winds were as yet feeble. The indraught to the storm area suspended the current up the Gangetic plain, and light irregular winds obtained there. The rainfall column shows that the storm had given moderately heavy general rain in Burma, and that it had produced an almost complete cessation of rain in Bengal and Northern and Central India generally. The following gives the average actual and normal rainfalls of the previous 24 hours in each province of Northern India and in Lower Burma :—

PROVINCE.	RAINFALL.	
	Actual past 24 hours.	Normal. average rainfall of day.
	Inch.	Inch.
Assam	0	0·30
Bengal	0·12	0·36
Behar	0	0·39
North-Western Provinces . .	0·12	0·28
Central Provinces . . .	0·29	0·31
Punjab	0	0·08
Rajputana	0	0·12
Burma	0·81	0·57

The following table gives the observations taken at 4 P. M. of the same day at selected stations :—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Port Blair . . .	29·824	+·132	+·027	W.-S.-W.	13	144	5	Misty.
Mergui . . .	·831	+·066	+·017	S.-W.	2	100	10	
Moulmein . . .	·793	+·102	+·025	S.	6	200	10	Drizzling.
Rangoon . . .	·754	+·141	−·016	S.	11	275	7	Do.
Thayetmyo . . .	·737	+·105	+·024	S.	12	247	10	Raining, dust-storm.
Toungoo . . .	·735	+·101	−·010	S.-S.-E.	5	160	10	Raining.
Bassein . . .	·724	+·171	−·016	S.-E.	9	300	10	
Diamond Island . .	·715	+·155	−·071	S.-W.	10	143	5	
Akyab . . .	·658	+·038	−·058	S.	12	400	8	
Chittagong . . .	·653	+·057	−·040	S.	4	100	10	
Saugor Island . .	·537	−·064	−·080	N.-E.	15	150	10	

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
lcutta	29·564	—·026	—·061	N.-E.byE.	6	120	10	Drizzling.
lse Point	·524	—·096	—·108	N.	13	163	10	
palpur	·536	—·086	—·121	W.-S.-W.	7	100	8	
:agapatam	·529	—·060	—·106	S.	1	25	10	
:underabad	·630	—·012	—·056	N.-N.-W.	14	200	5	
gpur	·581	—·054	—·056	N.-N.-W.	11	220	8	Thunder.
ikalda	26·111	—·014	—·052	N.	(?)	(?)	8	Squally; thunder.
anda	29·613	—·015	—·047	Calm.	3	75	6	
›ni	·615	—·029	—·031	N.-N.-W.	5	125	6	
›bulpore	·646	—·027	—·007	N.-E.	3	100	6	
zaribagh	·587	—·024	—·044	E.	12	171	10	Overcast; thunder.

These observations show that the barometer continued to rise in Burma, and at it was falling slowly and steadily in Orissa and the North Madras coast stricts. Weather was improving in Lower Burma, but was still unsettled; ies were overcast, and light to moderate rain was falling. Winds were stronger ın usual at all the coast stations of the Bay excepting Vizagapatam, but were where violent. Even at Diamond Island, which was nearest to the storm and the eastern quadrant, they only averaged 10 miles per hour. The only explation of this fact appears to be that the indraught to the storm at this time was iefly maintained by the southerly winds of the Andaman Sea, and that strong lraught from the south of the Bay of Bengal had either not yet commenced or s just commencing. Skies were now generally overcast in Bengal and the West ast districts and cloud was extending and increasing in amount in the Central ovinces.

The following gives a summary of the observations taken on board ships in : Bay of Bengal and Andaman Sea on the 15th :—

VESSEL.	Hour.	POSITION.		BAROMETER.			WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Variation from normal.	Direction.	Force.	
		° ′	° ′						
ıty of Linlithgow	Noon	0—59	87—22	30·40	29·92	...	W.	5	Light squalls with showers.
ıty of Dumfries.	Noon	1—51	85—27	29·74	·92	...	W.	...	Light breezes, frequent rain-squalls.
ehan	8 A. M.	...	...	30·20	·90	—·04	S.-W.	4	Fine clear weather.
	Noon	6—17	81—40	·20	·90	—·02	S.-W.	4	
'e	8 A. M.	...	...	29·99	·84	—·04	W.	6	Clear.
	Noon	10—49	83—41	30·00	·83	—·03	W.	7	Cloudy.
oora	8 A. M.	...	...	29·99	·89	—·03	W.-S.W.	4	Frequent heavy rain-squalls.
	Noon	10—00	96—10	·97	·87	—·03	S.-W.	4	
ıt Olivet	8 A. M.	...	...	·98	·80	—·08	S.-W.	6	Heavy squalls and rain.
	Noon	12—10	90—25	·97	·79	—·07	S.-W.	6	

VESSEL.	Hour.	POSITION.		BAROMETER.			WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Variation from normal.	Direction.	Force.	
		° ′	° ′						
Avagyee . .	Noon	Tavoy	river	29·64	29·95?	...	S.-S.-E. to S.-S.-W.	...	Rain-squalls and unsteady winds.
City of Edinburgh	8 A. M.	14—14	85—06	·54	·70	—·15	W.-S.-W.	5	South-westerly swell; cloudy.
	Noon	13—31	84—50	·54	·70	—·13	W.-S.-W.	5	Dull, gloomy weather.
Bombay . .	8 A. M.	13—50	85—02	·50	·70	—·15	...	...	Fresh wind; cloudy.
	Noon	14—29	85—16	...	...	..	...	...	Sudden shifts in wind, which is steadily increasing in force; high cross sea.
Cæsarea . .	8 A. M.	...	...	..	...	...	...	...	Squally to north-west; heavy showers; heavy clouds from north-east; lower scud from north-west.
	Noon	16—19	85—46	·57	·63?	—·17?	S.-W. to W.-N.W.		
Glenlin . . .	Noon	15—40	86—54	·75	·70?	—·10?	W.	5	Heavy squalls; vivid lightning; confused northerly sea.
Ethiopia . .	Noon	16—07	81—34	·68	·70	—·09	S.-S.-W.	2	Cloudy; much lightning.
Medea . . .	8 A. M.	...	...	·81	·69	—·11	W.	3	Clear.
	Noon	16—34	83—50	·80	·67	...	W.	3	Cloudy.
Frankistan . .	Noon	16—37	88—18	·51	·62	—·17	W.-N.-W.	5	Squally with rain; bad weather to north-east; easterly swell.
Shah Jehan . .	8 A. M.	...	...	·50	·43	—·35	N.-N.-W.	...	Stormy in the afternoon.
Africa . . .	Noon	Elephant Point.		·85	·89?	...	...	...	Moderate winds and showers.
Shahsada . .	7 P. M.	Passed Elephant Point		·82	·79	—·03?	S.	..	Heavy squalls; moderate breeze.
Palitana . .	8 A. M.	Rangoon river.		...	...	...	S.-S.-E.	...	Fresh wind, squally; sea smooth.
	Noon	...	...	·88	·82	—·02	S.-S.-E.	5	
Bengal . .	8 A. M.	...	...	·71	·62	—·15	N.	5	Fresh wind and overcast.
	Noon	20—37	88—04	·70	·61	—·13	N.-N.-W.	5	
F. L. V. Meteor .	10 A. M.	20—46	87—39	·82	·67	—·08	N.-N.-W.	3	Moderate south swell and unsettled appearance.
F. L. V. Planet . .	„	21—15	88—11	·84	·67	—·08	N.-W.	2	Sea very rough, blowing a strong gale with heavy rain-squalls at night.
F. L. V. Hesperus .	„	21—26	88—06	·82	·67	—·08	N.-W.	2	Sea smooth.
F. L. V. Canopus .	„	21—02	88—46	·84	·67	—·08	N.-N.-W.	4	Unsettled appearance to south-east; moderate north breeze.

There was not a single ship sufficiently near to the centre during the day to enable its position to be determined with exactness. After the storm crossed the Bassein hills and passed into the Bay of Bengal on the morning of the 14th, it apparently advanced with an almost constant velocity of between 13 and 14 miles per hour across the north of the Bay, and increased in intensity as it approached the Orissa coast. The evidence of this increase of intensity is given in the observations of the pilot-vessels *Coleroon* and F. L. V. *Canopus* discussed below. Assuming that it moved with an approximately constant velocity of 13½ miles per hour across the Bay, its position at 8 A. M. of the 15th would be 320 miles west-north-west of its position at the same hour of the 14th, or in about Lat. 18½° N. and Long. 90½° E. On the same assumption the position at noon would be about Lat. 19° N. and Long. 89½° E.

The two following tables give the position of several vessels with respect to the centre at 8 A.M. and noon :—

8 A.M.

Vessel.	Bearing of Centre.	Distance of Centre.	Wind.	Force.	Bearing Angle.	Weather.
					°	
Mount Olivet . .	N.	450	S.-W.	6	132½	Squally, with rain.
Glenlin	N.-E.	290	W.	5	133½	Squally; confused sea.
Frankistan . . .	N.-N.-E.	200	W.-N.-W.	5	110	
Bengal . . .	E.-S.-E.	180	N.	5	126	Fresh wind and overcast.
Culna . . .	S.-E.	200	Variable	1	?	Sea smooth.

Noon.

Vessel.	Distance and bearing of Centre.	Bearing Angle.	Wind.	Force.	Weather.
		°			
Frankistan .	200 miles N.-N.-E. .	90	W.-N.-W.	6	Squally with rain.
Glenlin . .	270 miles N.-E. . .	125	W.	5	Heavy squalls.
Culna .	200 miles S.-E. by S. .	?	Variable	5	Heavy squalls.

The weather outside the storm area in the Bay is fully shown by the extracts from the logs. In the south of the Bay normal winds and weather prevailed. The winds varied in strength from 4 to 7 and frequent rain-squalls occurred with intervals of fine weather. The average strength of the winds in the south of the Bay during September is 4. In the centre of the Bay the weather was dark and gloomy and unsettled. Frequent squalls occurred, and the wind was unsteady but increasing in force in the western half, whilst strong and steady south-west winds were blowing in the eastern half.

The *Frankistan* and *Shah Jehan* were nearest to the storm centre at noon. The *Frankistan* proceeding northwards was in Lat. 16°37′ N. and Long. 88°18′ E. at noon. At that time she was in the south-west quadrant and had squally weather with west-north-westerly winds. The *Glenlin* was 100 miles to the west-south-west of the *Frankistan* in Lat. 15°·40′ N. and Long. 86°·54′ E. She had westerly winds with heavy squalls and a confused northerly sea. The *Shah Jehan* was probably almost due west of the storm centre at noon, and at a distance of about 140 miles. Her log simply states that she experienced stormy weather during the afternoon. It is hence probable that she continued to advance slowly northwards whilst the storm centre was passing in front of her, and that she was 50 or 60 miles from the centre when nearest to it. The *Cæsarea*, 270 miles to the west-south-west of the centre at noon, had changeable winds and squally weather. The *Bengal* proceeding in a north-north-east course to the Hughli was 135 miles north-west of the centre at noon. She had light winds and fine weather during the morning. Winds increased to 5 at noon and shifted to east by south at 8 P. M., when they were of force 7 and accompanied with heavy squalls and rain.

At the head of the Bay light to moderate north-westerly winds prevailed in the morning. The sea was smooth, but the weather appeared unsettled to the south-east. During the afternoon it became rapidly worse and at night it blew a strong gale with heavy rain-squalls. The storm centre at midnight was about 100 miles to the south-south-west of the light vessels at the entrance to the Hughli, and 120 miles south-south-west of Saugor Island. The pilot vessels *Coleroon* and *Canopus* experienced the full strength of the storm late on the evening of the 15th and on the early morning of the 16th. The storm centre passed a little to the south of False Point at about 3 A.M. of the 16th. It will be most convenient to give the accounts of the weather as experienced on board the pilot-vessels and at False Point before proceeding to the discussion of the observations of the 16th.

The observations taken at False Point and on board the pilot-vessel *Coleroon*, and the floating light vessel *Canopus*, are especially interesting, as they are the first which show the full intensity of the storm. They are hence given in full. The following table gives those taken on board the *Coleroon*. The error of her aneroid was determined by a comparison made some years ago by Branch Pilot Mr. Elson to be +0·32″. A comparison of the readings on board the *Coleroon* taken with those on the neighbouring vessels shows that it has since altered, and was almost certainly +0·13″ at the time of the storm. Hence the correction —0·13″ has been adopted.

Date.	Hour.	Barometer.			Wind.		Weather.
		Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
15th	2 A.M.	...	...	...	...	...	Heavy rain-squall, with vivid lightning.
	8 A.M.	29·73	29·60	—·15	N.-W.	2	Light north-west airs, and overcast; sea smooth.
	Noon.	·72	·59	—·14	N. by W.	3	
	4 P.M.	·56	·43	—·23	N.-E. by E.	5	4-45 P.M.—Sea rising fast; wind increasing to a whole gale.
	6 P.M.	·54	·41	—·28	N.-E.	8	
	8 P.M.	·49	·36	—·37	N.-E. by E.	9	Blowing a very hard north-east gale, with very high sea.
	10 P.M.	·35	·22	—·52	N.-E. by E.	10	
	Mid-night.	·24	·11	—·62	E. to E.-N.-E.	12	Very heavy gale from the east, with tremendous sea.
16th	1-30 A.M.	·18	·05	—·66	E.-S.-E.	12	Hurricane from east-south-east, with tremendous sea.
	2 A.M.	·24	·11	—·59	S.	12	Hurricane.
	3 A.M.	·28	·15	—·54	S.	12	
	4 A.M.	·34	·21	—·48	S.	11	Storm diminishing in violence.
	6 A.M.	·45	·32	—·39	S.	8	Hard gale, with very high sea.
	8 A.M.	·61	·48	—·27	S. by E.	6	
	4 P.M.	·66	·53	—·14	S. E.	4	

The *Coleroon* was on her usual station at the Sandheads on the morning of the 15th. The weather was dull, skies overcast, winds very light (from the north-west) and sea smooth. No important change of wind occurred until about 4 P.M., when the wind veered to north-east and began to increase rapidly in force and the sea to rise. She then ran to south-west. The wind increased in force from 5 to 10 between 4 P.M. and 10 P.M., but remained unchanged in direction. At midnight it was blowing a very heavy gale from the east with a tremendous sea. The vessel at that time was probably not more than 30 miles to the north of the centre. The rapid westerly advance of the storm now brought the *Coleroon* into the eastern quadrant, and at 1-30 A.M. of the 16th the wind blew with hurricane force (12) from east-south-east. She experienced hurricane winds until about 3-30 A.M. The winds then began to moderate, and at 6 A.M. the vessel was found to be near to False Point. Her barometer fell from 29·56″ (uncorrected) at 4 P.M. to 29·18″ at 1-30 A.M., and rose again to 29·61″ at 8 A.M. It hence fell ·38″ in 9½ hours and rose ·43″ in 6½ hours. She experienced winds of force 8 or upwards between 6 P.M. and 6 A.M., or for 12 hours. Taking into account so far as possible the motion of the vessel and her position with respect to the centre, the diameter of the storm area (defined by winds of force 8 or upwards) was at least 150 miles, and of the area of hurricane winds (force 11 and 12) about 70 miles.

The meteorological information given in the log of the *Canopus* is much less in amount. It is as follows:—

Date.	Hour.	Barometer.			Wind.		Weather.
		Actual.	Corrected.	Variation from normal.	Direction.	Force.	
15th	8 A. M.	...	...	...	E.-N.-E.	...	Wind increasing; light rain-squalls. Weather looking very wild.
	10 A. M.	29·69	29·55	—·23	N.-N.-W.	4	
	4 P. M.	·47	·33	—·36	E.-N.-E.	8	Blinding rain-squalls; confused sea.
	6 P. M.	..	...	...			Terrific confused sea.
16th	4 P. M.	·63	·49	—·20	S.-E.		Very high sea; sea and wind falling fast since early dawn. Blew fresh to moderate gale whole of 16th and 17th, with very heavy swell.

The commander describes the weather prevailing as follows:—

> "For days before the storm the winds were light and variable, the sea very much disturbed by eddies, and the weather very sultry. There was very vivid lightning from north round to east-south-east, which on the night of the 14th and morning of the 15th was accompanied with continuous distant thunder to the east. On the 14th there were light northerly breezes and a swell from the south-south-east. For days before, although the weather was calm and sea smooth, rainbows in the early morning to the west, circles round the sun, halos and large circles round the moon, were very prominent."

As no barometric observations were recorded during the interval from 4 P. M. of the 15th to 4 P. M. of the 16th, it is not possible to determine when the *Canopus* was nearest to the centre.

The following gives a very complete and valuable series of observations taken at False Point by the Port Officer :—

Date.	Hour.	Barometer corrected.	Wind.	Weather.
15th September.	6 A. M.	29·65	N.-E	Light winds and light squalls with showers of rain; overcast sky, and dark gloomy weather.
	8 A. M.	·65	N.-E.	Ditto ditto.
	10 A. M.	·70	N.-E.	Ditto ditto.
	2 P. M.	·53	N.-E.	Fresh breeze and squally.
	4 P. M.	·50	N.-E.	The same wind and weather, but with very threatening appearance; heavy bank of clouds to the east and north-east, and heavy thunder and lightning.
	6 P. M.	·48	N.	Wind veered round to north, and increased to a heavy gale, with weather as above.
	8 P. M.	·49	N.	The same weather.
	10 P. M.	·39	N.-N.-W.	Ditto.
	10-30 P.M.	·36	N.-N.-W.	The same weather, but squalls getting heavier and quicker; wind veering back to north-east.
	11 P. M.	·31	N.-E.	Blowing a severe storm, with very heavy gusts; thick, laden, overcast sky, and nasty-looking weather.
	11-30 P M.	·24	N.-E.	The same weather.
16th September.	Midnight	·18	N.-E.	Ditto.
	12 30 A. M.	·17	N.-E.	Wind and squalls increasing and more furious than ever, with very nasty, dirty weather. Wind hauling back to north.
	1 A. M.	·02	N.	The same weather.
	1·30 A. M.	28·93	N.	The same weather. Wind veering between north and north-east.
	2 A. M.	·91	N.-E.	The same weather.
	2·30 A. M.	·85	N.-E.	Ditto.
	3 A M.	·90	E.-N -E.	Squalls and gusts fiercer than ever; wind hauled to the eastward and came down in gusts of hurricane force, with blinding sheets of rain.
	3·30 A. M.	·90	E.	The same weather as above.
	4 A. M.	29·14	E.	Ditto.
	4·30 A. M.	·21	E.	Ditto.
	5 A. M.	·28	S.-E.	Gusts not quite so heavy or so frequent as they were.
	5·30 A. M.	·34	S-S.-E	Wind moderated considerably, but still blowing very hard.
	6 A. M.	·40	S.	Blowing a hard gale of wind, with heavy squalls and blinding sheets of rain.
	10 A. M.	·55	S.-W.	Blowing a stiff gale of wind, with heavy squalls of wind and rain, and thick, hazy weather.

A comparison of readings of the aneroid at the Port Office, False Point, with the corresponding readings at the Light-house, shows that the error of the instrument is very small, probably not more than —·01″. The readings are hence assumed to be practically correct.

The Port Officer described the weather during the storm in the following terms :—

"The weather was squally, with light winds, on the morning of the 15th, but did not assume a threatening appearance until after 4 P. M., when a heavy bank of clouds began to be visible on the eastern horizon. The weather became rapidly worse, and at 3 A. M. the wind was of hurricane force and accompanied with blinding sheets of rain. The barometer was lowest at 2-30 A. M. The hurricane winds were hence not felt until about half an hour after the instant of lowest barometer. They continued until about 4-45 A. M., or for nearly two hours. The weather began to moderate at 6 A. M. It was then blowing a hard gale with heavy squalls and blinding sheets of rain. At daylight the station appeared to be a perfect wreck; the thatch was blown off all the houses and the sea resembled a cauldron seething with foam."

The barometer at False Point fell from 29·53" at 2 P.M. to 28·85" at 2-30 A.M., or ·68" in 12½ hours, and rose to 29·55" at 10 A.M., or through ·7 inch in 7½ hours. It will thus be seen that there is a striking agreement between the observations taken on board the pilot-vessel *Coleroon* and at False Point. The False Point observations indicate that the storm when crossing the coast was from 180 to 200 miles in diameter, that the winds of strongest force were experienced in the east and south quadrants, and that the barometer rose much more quickly in the rear of the storm than it fell in front.

Another important feature brought to notice by these observations is that although the storm was advancing in a straight course to False Point, the wind shifted considerably before the centre passed. It backed from north-east at 6 A.M. of the 15th, to north-north-west at 10 P.M., veered again to north-east at 11 P.M., backed to north at 1 A.M., and veered to north-east at 2 A.M. The wind hence shifted backwards and forwards through five points in this period of 18 hours, during which the bearing of the centre was unchanged. These changes may in part have been due to peculiarities in the geographical conditions of False Point. They, however, also indicate that the angle between the bearing of the centre and the wind direction is to some extent variable, and hence that it is not possible to give any exact, and, at the same time, simple rule for the bearing of the centre in terms of the wind direction.

The following account of the damage done at False Point by the cyclone is extracted from the Calcutta *Englishman* newspaper:—

"The cyclone was of unusual severity. Its approach was notified by storm signals and all preparations made for its approach. The boats were all secured and moored in proper places; the residents at the Point were all got into the verandah of the new refuge building, which has been constructed on a mound many feet above the mark of the last storm-wave, and the safety of Government and private property looked to. It commenced blowing on the afternoon of the 15th with very heavy squalls of wind and rain, a heavy overcast sky and threatening-looking weather. The wind increased materially during the night, and on the morning of the 16th it blew with terrible and hurricane violence. At 2-30 A.M. the centre of the storm was apparently very close to the Point, at which time the lowest reading of the barometer 28·85" was recorded. At 5 A.M. the barometer rose and the wind decreased considerably in violence. At 6 A.M. there was a moderate sea with very strong squalls and blinding sheets of rain. The thatch was blown off the roofs of all the buildings. The south wall of the dâk bungalow was blown down, and the foundations of three of the cooking houses shaken. The Reddie Head bund gave way in three places, and from the bund round the workshops the sea has encroached a good deal. The bund leading out to the beach and to the site of the old Police station has been heavily breached. The boats were all sunk at their anchors and are all more or less broken. One boat belonging to the wreck of the *Ganges* was completely blown away from her moorings and landed at the back of the Reddie Head. Three buoys have also been washed away. The water rose over the island at least 3 feet higher than the ordinary spring-tide, and the whole of the rooms in the refuge buildings were flooded more or less with the rain beating in. At the height of the storm the anemometer, before it was washed away, registered a wind velocity of 70 miles an hour. The beacons at Reddie Head, Prince Andrew's Black Buoy, and at Temple tree were all blown down. At Dodswell Island, from Reddie Head up to the north end of Stiffe Island, 2 or 3 feet of sand has been washed off the surface, and that part of the island is now covered with water at ordinary spring-tides. Further down south, at Turtle Point, the sea has washed through and left a gap of about 100 feet broad, which is covered at half flood. A native brig, the *Sra Setwarnamy,* which was lying in the harbour, broke adrift and was shattered and sank about 2 miles north-east of the Baroni river. No loss of life is reported to have occurred. At Jumboo Station very little damage was done. Most of the people who were in the place moved into safety 4 miles further up. Even there the water rose 3 feet above the height of the ordinary spring-tides."

September 16th.—The previous history of the storm has shown that the centre crossed the coast of Orissa a little to the south of False Point on the early morning of the 16th at about 3 A. M. The storm was at that time of very considerable intensity. The depression at the centre was nearly eight-tenths of an inch, and the area of stormy winds (force 8 and upwards) was upwards of 150 miles in its longest diameter. We have now to follow the history of the storm during its progress over the land area of India.

The following table gives the 8 A. M. land observations at stations in and near the storm area :—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PAST 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Masulipatam	29·649	−·063	−·154	N.-W.	6	100	96·6	+4·6	79·0	+1·6	10	...	
Vizagapatam.	·574	−·118	−·164	W.	1	25	87·9	−0·3	83·1	?	10	...	
Gopalpur .	·471	−·220	−·221	S.-S.-W.	11	157	90·7	+3·2	79·3	−1·1	10	1·19	Sea rough.
False Point.	·480	−·187	−·138	S.-E.	0	0	86·9	+0·2	77·1	−0·3	10	4·08	Squally.
Cuttack .	·375	−·325	−·208	S.	5	250	87·9	+1·0	75·8	−1·5	10	2·60	
Saugor Island	·651	−·026	−·094	E.-S.-E.	24	240	88·2	+0·5	78·0	−1·5	10	1·71	Sea very rough.
Calcutta .	·684	+·008	−·026	E.	11	220	91·5	+4·1	77·2	−1·0	8	0·20	Squally.
Burdwan .	·689	+·015	−·033	E.-S.-E.	5	167	91·6	+2·2	78·9	−0·4	10	0·12	
Hazaribagh.	·709	−·018	−·046	E.-S.-E.	10	143	87·5	+3·5	71·7	−0·9	10	0·45	Drizzling.
Patna .	·734	+·017	−·009	E.	3	100	95·5	+5·0	82·2	+1·9	9	0·21	Showery.
Allahabad .	·708	−·028	+·003	N.-E.	2	67	92·7	+2·2	77·6	+0·2	8	0·29	
Sutna .	·709	−·077	−·023	N.-N.-E.	4	57	87·1	−0·6	75·1	0	3	0·69	Fine.
Jubbulpore.	·735	−·021	−·023	W.-N.-W.	2	67	85·9	−0·4	73·1	0	9	0·03	Fine.
Seoni . .	·699	−·039	−·055	N.-N.-W.	4	100	85·1	+0·7	73·1	+1·7	5	0·02	Distant lightning.
Nagpur .	·676	−·056	−·080	N.-N.-W.	5	100	90·7	+4·4	76·0	+1·8	9	0·03	Fine.
Raipur .	·601	−·103	−·134	N.-W.	6	100	88·0	+1·5	77·6	+3·4	10	0·93	
Sambalpur.	·433	−·261	−·269	N.	7	350	91·4	+2·4	76·6	−0·8	10	1·05	

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PAST 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Chanda .	29·679	—·058	—·095	N.-W.	4	100	91·9	+5·7	76·6	+2·5	10	0·46	Distant lightning.
Sironcha .	·659	—·063	—·148	W.-N.-W.	4	133	91·7	+5·1	79·1	+3·9	7	0·04	
Chyebassa .	·593	—·092	?	E.-N.-E.	5	?	89·1	?	74·7	?	10	0·53	

A reference to the chart of the day (Plate XXII) will show that the cyclonic storm and circulation covered Orissa, the Central Provinces, the adjacent districts of Bengal and Madras, and the north-west of the Bay. The barometer was rising rapidly in Burma. It was also rising in Assam, North Bengal, and the Indus valley. Elsewhere it was falling, but the changes were small, except in the storm area.

The centre at 8 A.M. was about 20 miles to the west of Cuttack and crossing the Orissa hills. The barometer at the centre at that hour was probably not lower than 29·3″ and the depression not more than ·4″. Hence, during the five hours after it crossed the coast, the decreased motion in the lower strata caused by friction had accompanied a large decrease in the amount of the depression (*viz.*, from 0·8 inch to 0·4 inch). Strong south to east winds were blowing at the head of the Bay and the sea was very rough. Heavy rain was falling in Orissa and moderate rain in Bengal.

The following gives rainfall data for the three districts of Pooree, Cuttack, and Balasore in Orissa, and the adjacent Midnapore district in Bengal on the 14th, 15th, and 16th:—

DISTRICT.	14TH.		15TH.		16TH.		Total average rainfall of the 15th and 16th.
	Average actual rainfall in district.	Maximum in district.	Average actual rainfall in district.	Maximum in district.	Average actual rainfall in district.	Maximum in district.	
Pooree . .	...	...	1·87	5·40	3·87	7·10	5·74
Cuttack . .	...	...	0·77	2·30	2·60	3·40	3·37
Balasore . .	0·02	0·08	1·57	3·35	2·10	2·68	3·67
Midnapore . .	...	...	0·80	1·52	1·24	2·45	2·04

Hence an average rainfall of 4 inches was received over the province of Orissa on the 15th and 16th. Light to moderate rain was falling in the outskirts of the storm in the Central Provinces and also in the west-coast districts of Bombay and Malabar. Weather was fine over the whole of Northern and Central

India, and light and in some cases unsteady winds prevailed. Skies were clear in the Punjab, Sind, and the western districts of the North-Western Provinces, but were clouded in other districts and overcast in the storm area.

The following brief description of the hills which the storm was now crossing is taken from Hunter's Statistical Account of Orissa:—

> "The Tributary States of Orissa occupy a succession of ranges rolling backwards towards Central India. They form, however, three water sheds from south to north, with fine valleys between, down which pour the three great rivers of the interior table-land. The southernmost is the valley of the Mahánadi, at some places closely hemmed in by peaks on either side and forming picturesque passes, at others spreading out into fertile plains, laden with rice, and watered by a thousand mountain streams. At the Barmul Pass, the river winds round magnificently-wooded hills, from 1,500 to 2,500 feet high. Crags and peaks of a wild beauty overhang its channel, which at one part is so narrow that the water rises 70 feet in time of flood. From the north bank of the Mahánadi the ranges tower into a fine water shed from 2,000 to 2,500 feet high, running north-west and south-east, which forms the boundary of the States of Narsingpur and Barambá. On the other side they slope down upon the States of Hindol and Dhenkánal, supplying countless little feeders to the Bráhmani, which occupies the second of the three valleys. From the north bank of this river the hills again roll back into magnificent ranges running in the same general direction as before, but more confused and wlider, till they rise into the Keunjhar water shed with peaks from 2,500 to 3,500 feet high, culminating in Maláyagiri, 3,895 feet above the sea, in the State of Pal Lahará. This water shed in turn slopes down into the third valley, that of the Baitarani, from whose eastern or left bank rise the hitherto almost unexplored mountains of Marbhanj, heaped upon each other in noble masses of rock from 3,000 to nearly 4,000 feet high, sending countless tributaries to the Baitarani on the south, and pouring down the Burábalang with the feeders of the Subarnarekhá on the north."

The 4 P. M. observations of the 16th given in the following table show that these high hills had practically no influence in modifying the course, velocity, or character of the storm:—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Masulipatam	29·513	—·048	—·170	W.	14	233	10	
Vizagapatam	·444	—·184	—·174	S.	5	125	10	
Gopalpur	·442	—·094	—·191	S.	38	543	7	
False Point	·535	+·011	—·086	E. by S.	?	?	9	
Cuttack	·495	—·029	—·105	S.	7	350	10	
Saugor Island	·609	+·073	—·008	E.-S.-E.	29	290	8	
Calcutta	·626	+·062	—·014	S.-E.	12	240	8	
Burdwan	·654	+·094	+·014	S.	5	167	10	
Hazaribagh	·621	+·002	—·034	E.-S.-E.	26	371	10	
Patna	·647	+·048	+·006	E.	10	333	10	Drizzling.
Allahabad	·599	—·026	—·029	N.-E.	5	167	10	Violent storm, followed by rain.
Sutna	·597	—·079	—·037	E.-N.-E.	16	229	8	Raining.
Jubbulpore	·638	—·020	—·016	N.	2	67	10	Strong wind.

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual reduced to sea-level.	Change since 4 P. M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Seoni	29·549	—·084	—·101	N.-W.	14	350	6	
Nagpur	·520	—·078	—·119	N.-N.-W.	13	260	10	
Raipur	·408	—·170	—·204	N.-N.-W.	17	283	10	Drizzling.
Sambalpur . . .	·380	—·200	—·206	E.	19	950	10	
Chanda	·558	—·070	—·102	W.	8.	200	10	Raining.
Sironcha . . .	·500	—·078	—·177	N.-W.	8	267	10	Overcast, drizzling.

These observations show that the centre at 4 P. M. was a little to the south-west of Sambalpur, probably in Lat. 21° 10′ North, and Long. 83° 45′ East. It had hence advanced about 200 miles in the previous 13 hours, or at the average rate of about 15 miles per hour since it crossed the coast. The barometer at the centre was probably 29·3″ and about three-tenths of an inch below the normal. Hence the character of the depression was unaltered since 8 A. M. A very great increase in the strength of the winds had occurred over the whole of the Central Provinces, and also in Ganjam, Orissa, South Bengal, and Behar. The average velocity during the previous six hours at Gopalpur was 38 miles per hour, and at Saugor Island 29 miles. It is, of course, certain that the Orissa hills must have influenced considerably the air motion in the lower strata and have tended to break it up. This effect was, however, of so little importance as to produce no perceptible result on the general character of the disturbance.

Assuming that the most probable position of the centre at 8 A. M. was 20 miles to the west of Cuttack, it had advanced with almost uniform velocity during the whole interval from its passage across the Orissa coast until 4 P. M., and at a rate very slightly greater than its velocity when crossing the Bay.

The storm during the evening continued to pass across the eastern districts of the Central Provinces in an almost due westerly direction with a velocity slightly exceeding 15 miles per hour. Skies were very heavily clouded and heavy rain was falling over the whole of the storm area proper.

The following gives a brief summary of the observations taken on board vessels in the Bay of Bengal on this day:—

VESSEL.	Hour.	POSITION.		BAROMETER.			WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
		° ′	° ′						
Benvenue . .	Noon	3—50	87—34	29·94	29·90	...	W.-N.-W. to W.	5	Squally and showery.
County of Dunfries . .	,,	6—10	86—10	·72	·90	—·02	W. to S.-W.	7	Fresh to strong breezes.

Vessel.	Hour.	Position.		Barometer.			Wind.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
		° ′	° ′						
Bancoora	Noon.	7—07	98—13	30·00	29·93	0	E.	2	Fine clear weather.
City of Edinburgh	8 A.M.	...	...	29·59	·75	—·14	S.-W. by S.	6	Sky overcast; high sea.
	Noon	9—45	83—17	·61	·77	—·10	S.-W. by S.	7	
Mount Olivet	8 A.M.	...	...	30·00	·82	—·08	S.-W.	5	Clear weather.
	Noon.	10—35	88—28	·00	·82	—·06	S.-W.	6	Sea high.
Africa	"	13—01	96—35	29·88	·92	+·04	S.	6	Rain-squalls.
Thisbe	"	14—09	85—24	·84	·67?	—·16	S.-W.	7	Frequent showers.
Medea	"	14—24	82—3	·80	·67	—·15	W.-S.-W.	4	Cloudy. Drizzling rain.
Glenlin	"	18—26	87—58	·80	·63	—·16	W. to S.	5	Squally.
Frankistan	"	18—03	88—37	·58	·69	—·10	S.-W.	...	Wind unsteady, with occasional sunshine.
Bombay	"	18—23	86—56	...	...	...	...	...	Fresh gale. Heavy rain.
Bengal	"	Saugor anchorage.		·73	·64	—·09	S.-E. by S.	4 to 5	Fresh wind.
Culna	8 A.M.	Calcutta		·66	·68	—·03	S.-E.	9	Heavy squalls.
F. L. V. Meteor	10 "	20—46	87—39	·71	·56	—·19	S.-E.	?	Tremendous heavy sea.
F. L. V. Canopus	10 "	21—02	88—40	·71	·55	—·20	S.-S.-E.	8	Long cross south and west swell. Moderate gale.
F. L. V. Hesperus	10 "	21—26	88—6	·70	·56	—·19	E.-S.-E.	8	Heavy sea.
F.L.V. Planet	10 "	21—15	88—11	·70	·54	—·21	E.-S.-E.	8	Sea very rough.

The preceding observations show that during the whole of the 16th strong south-west winds prevailed over the south and centre of the Bay. In Lat. 10° N. they were of force 5 and 6, and in Lat. 14°N. of force 7, and the weather was cloudy and squally with frequent showers. At the head of the Bay winds ranged in direction between south-south-east and east-south-east, and were of force 8 and 9. A fresh to heavy gale was blowing off the Orissa and Bengal coasts in the morning, but winds began to moderate in the afternoon. These winds brought up a very heavy sea during the day. The F. L. V. *Meteor* stationed at the Pilot's Ridge reported that she experienced a tremendously heavy sea in the morning.

The most important fact established by the observations recorded in the logs is that the weather improved rapidly during the afternoon and the sea went down very quickly, so that moderate winds with slight sea obtained over the north of the Bay next morning.

September 17th.—The following gives 8 A M. observations at selected stations:—

Station.	Barometer.			Wind.			Temperature during past 24 hours.						
	Actual reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.	Cloud proportion.	Rainfall in past 24 hours.	Weather.
Masulipatam	29·685	+·036	—·115	W.	9	150	94·6	+2·4	78·0	+0·6	10	0·12	
Vizagapatam	·665	+·091	—·091	W.	5	125	88·9	+1·2	79·1	?	10	—	
Gopalpur	·650	+·179	—·169	S.	30	429	93·2	+5·7	76·8	—3·5	5	0·77	Sea very rough.
False Point	·664	+·184	—·039	S.-E.	1	13	82·4	—3·8	77·1	—0·9	10	0·46	Squally.
Cuttack	·654	+·279	—·040	E.	4	200	87·9	—1·7	75·8	—1·8	10	0·18	
Saugor Island	·728	+·077	—·031	E.-S.-E.	20	200	88·7	+0·6	78·5	—1·0	9	0·55	Sea rough.
Calcutta	·735	+·051	—·003	E.-S.-E.	8	160	86·5	—0·1	77·2	—0·8	8	0·52	
Burdwan	·730	+·041	+·011	E.	4	133	87·6	—2·5	77·9	—1·2	10	0·60	
Hazaribagh	·698	—·011	—·038	S.	20	286	78·4	—6·1	72·2	—0·8	10	0·11	Squally.
Patna	·734	0	—·010	E.	9	300	92·4	+1·3	79·7	—0·4	8	0·20	Showery.
Allahabad	·649	—·059	—·064	E.-N.-E.	9	300	92·2	+1·1	78·6	+1·6	10	0·55	Thunderstorm.
Sutna	·610	—·099	—·112	E.	15	214	87·6	0	74·1	—0·3	5	0·32	Strong wind.
Jubbulpore	·603	—·132	—·116	N.-E.	6	200	87·4	+0·6	73·6	+0·4	10	1·37	Showery.
Seoni	·591	—·108	—·167	N.	10	250	84·1	—0·1	71·1	+0·2	10	1·45	Thunderstorm.
Nagpur	·503	—·173	—·242	N.-W.	12	250	92·7	+4·5	75·1	+1·1	10	0·47	
Raipur	·555	—·046	—·145	S.-E.	17	283	85·0	—1·3	73·1	—1·8	10	2·50	
Sambulpur	·612	+·181	—·096	S.-E.	11	550	87·5	—1·5	76·6	—0·9	10	0·04	
Chanda	·578	—·104	—·210	N.-W.	2	50	88·0	+1·0	74·7	+0·7	10	0·60	
Sironcha	·607	—·048	—·203	W.-S.-W.	5	170	90·2	+3·9	75·9	+0·2	9	1·23	
Chyebassa	·689	+·089	?	E.	3	?	83·4	?	75·2	?	10	0·32	
Akola	·633	—·112	—·162	N.-N.-W.	10	167	92·4	+6·0	75·8	+3·0	10	—	
Amraoti	·578	—·146	—·181	W.	8	200	92·6	+6·1	74·8	+2·9	10	0·02	Distant lightning.
Pachmarhi	26·212	—·183	—·145	N.-W.	8	133	79·7	+3·1	69·2	+2·6	10	1·23	Showery.
Khandwa	29·656	—·121	—·135	N.-W.	8	133	93·2	+7·5	75·3	+2·3	5	0·03	Distant lightning.

The barometer fell very rapidly during the night of the 16th in the Central Provinces. It fell also over the whole of the Peninsula, Sind, Rajputana, the Punjab, and North-Western Provinces. It rose very rapidly in Orissa, Ganjam, and the north-west of the Bay, and briskly in Bengal and Burma.

The barometric changes were hence almost entirely due to the westward movement of the storm area. The centre of the depression was a little to the east-north-east of Nagpur at 8 A. M. The height of the barometer at the centre was probably 29·45," and the depression three-tenths of an inch. Winds were now decreasing in force at the head of the Bay, but were still considerably above their normal strength. Strong cyclonic winds prevailed over nearly the whole of the Central Provinces. One very important feature in the circulation was the strong easterly winds which prevailed in the northern quadrant at very considerable distances from the centre. Thus at Hazaribagh, Patna, and Allahabad, all of which were upwards of 300 miles from the centre, the winds were three times their normal strength. The indraught to the depression had on the other hand produced a moderate increase in the force of the winds in Berar and the Bombay coast districts, but the chief indraught to the storm area was, as hitherto, from the Bay of Bengal. Hence although the storm centre was now midway between the two seas, it had failed to produce any large inrush of moist winds from the Arabian Sea. The same fact is shown even more strikingly by the rainfall distribution of the previous 24 hours. More or less heavy rain had been received over Bengal, the North-Western Provinces, the Central Provinces, and Berar. Light showers had fallen in the Malabar and Bombay Coast districts, Khandeish Guzerat, and the western districts of Central India. The following gives the average rainfall of the previous 24 hours in different districts:—

Province.	Average rainfall of 24 hours preceding 6 P.M. 17th September.	Normal average daily rainfall, September.
Orissa	0·64	0·46
Bengal	0·64	0·29
Behar	0·29	0·21
Chutia Nagpur	0·27	0·22
North-Western Provinces	0·57	0·26
Central Provinces	1·22	0·31
Berar	1·16	0·20
Khandeish	0·08	0·16
Guzerat	0·12	0·23
Bombay Coast Districts	0·60	0·37

The rainfall in the storm area was hence more moderate in amount than it was on the 16th, and the heaviest rainfalls were registered in districts to the north of the central area. A complete statement of the rainfall of all districts affected by the storm is given in Appendix A. The following gives all rainfall of the day in the whole of India exceeding 3 inches in amount:—

Province.	District.	Station.	Rainfall of 24 hours preceding 6 P.M. 17th September.
North-Western Provinces.	Agra	Bah	6·08 inches.
	Etah	Kashgunge	3·20 "
		Etah	3·80 "
	Banda	Girwan	3·37 "
		Karwi	3·61 "
	Tarai	Kilpari	3·50 "
Central Provinces.	Saugor	Karai	4·43 "
	Seoni	Seoni	3·65 "
	Hoshangabad	Pachmarhi	4·00 "
	Betul	Badnur	4·02 "
		Chicholi	6·22 "
	Chanda	Arnori	3·10 "
	Bhandara	Sakoli	3·30 "
		Terora	3·50 "
	Raipur	Drug	3·50 "

The following table gives the average actual district rainfall of the 15th, 16th, and 17th in the Central Provinces and of Berar, and illustrates the distribution of rainfall due to the storm at this time:—

	District.	Average district rainfall, September 1888.			Total, 15th to 17th.
		15th.	16th.	17th.	
Central Provinces.	Saugor	0·85	0·38	1·36	2·59
	Damoh	0·13	0·31	0·32	0·76
	Jubbulpore	0·41	0·35	0·45	1·21
	Mandla	...	0·55	0·35	0·90
	Seoni	0·33	0·39	2·32	3·04
	Narsinghpur	0·58	0·57	0·76	1·91
	Hoshangabad	0·21	0·44	1·94	2·59
	Nimar	...	...	0·48	0·48
	Betul	...	0·27	2·77	3·04
	Chhindwara	0·31	0·38	1·37	2·06
	Wardha	...	0·05	0·59	0·64
	Nagpur	...	0·12	1·37	1·49
	Chanda	...	0·41	1·41	1·82
	Bhandara	0·20	1·17	2·86	4·23
	Balaghat	0·14	...	2·10	2·24
	Raipur	0·23	0·38	2·13	2·74
	Bilaspur	...	0·16	0·36	0·52
	Sambalpur	0·10	1·05	0·41	1·56
	Kalandi State	...	2·23	1·00	3·23
	Bastar State	...	1·70	0·14	1·84
	Berar	0·07	0·21	1·16	1·44

An important effect of the storm was the large reduction of temperature it produced over the whole of Central and Northern India (excepting Sind and the Punjab). The mean temperature of the North-Western Provinces was 5⅓° lower on the 17th than on the 16th, and of the Central Provinces 4½° lower. It was, on the other hand, hotter in Sind and the West Punjab, the highest temperatures recorded on this day being 108·9° at Jacobabad and 105·5° at Dera Ismail Khan.

The centre at 8 A. M., as already stated, was a little to the east of Nagpur, or in about latitude 21¼°N. and longitude 80°E. It had hence moved almost due west during the preceding 24 hours through a distance of about 380 miles, or at an average rate of 16 miles an hour. During the previous 24 hours no large change had occurred in the chief features of the storm. The amount of the depression, the direction and rate of advance, and the occurrence of heavy rain chiefly in the western and northern quadrants were practically unchanged. The storm area was, as hitherto, oval in shape, the greatest diameter running east and west.

The next position of the storm centre is given by the 4 P. M. observa- ons contained in the following table:—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
sulipatam . .	29·593	+ 080	−·090	W.	13	217	10	
agapatam . .	·567	+·122	−·055	W.	5	125	10	
palpur . . .	·583	+·141	−·078	S.	28	400	4	Strong wind.
se Point . . .	·621	+·086	−·021	S.-S.-E.	19	238	10	
tack . . .	·603	+·109	−·019	?	3	150	10	
gor Island . .	·641	+·031	+·004	S.-E.	27	270	10	
cutta . . .	·647	+·021	−·005	S.-S.-E.	6	120	10	
dwan . . .	·596	−·058	−·049	E.-S.-E.	4	133	10	
zaribagh . . .	·598	−·016	−·059	S.-E.	16	229	10	Passing showers.
na	·643	−·004	−·005	E.	13	433	10	
habad . . .	·540	−·056	−·083	E.	14	467	5	Strong wind; cloudy.
na	·512	−·079	−·125	E.	20	286	8	
bulpore . . .	·546	−·083	−·108	E.-N.-E.	13	433	6	Cloudy; strong wind.
ni	·482	− 069	−·172	E.	6	150	10	Raining.
gpur . . .	·382	−·139	−·254	W.-S.-W.	21	420	10	Strong wind; raining.
pur	·472	+·060	−·154	S.-S.-W.	12	200	10	Drizzling.
balpur . . .	·530	+·152	−·062	S.-E.	7	200	10	Ditto.
nda . . .	·471	−·082	...	W.-N.-W.	11	275	10	
ncha . . .	·485	−·012	−·196	S.-S.-W.	8	267	7	Cloudy, thunder, drizzling.
la	·516	−·024	−·142	N.-N.-W.	12	200	10	Raining.
raoti . . .	·450	−·077	−·191	W.-N.-W.	16	400	10	
hmarhi . . .	26·111	−·168	−·163	N.-E.	9	150	10	Strong wind.
ndwa . . .	29·517	−·062	−·162	N.	12	200	10	Thunder.

These observations show that the centre was probably not more than or 20 miles to the north or north-north-west of Nagpur. It had hence not oved more than 70 miles during the previous 8 hours, and its velocity had dimi- shed very considerably. The depression at the centre was nearly three-tenths an inch, and practically unchanged in amount. Very strong westerly winds evailed at Nagpur and Amraoti, but in West Berar and Khandeish the wind ce had diminished to a slight extent. A largely increased indraught was shown the northern quadrant by the wind velocities recorded at Patna, Allahabad, d Jubbulpore, where the winds were now nearly five times their normal ength. Hence the chief indraught to the storm area was as hitherto from the y of Bengal.

The following table gives meteorological data of the 17th for the Bay of ngal :—

VESSEL.	Hour.	POSITION.		BAROMETER.			WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
		° ′	° ′						
of Cambridge	Noon.	5—58	80—04	29·92	...	...	S.-W.	3	Moderate wind.
of Edinburgh	,,	6—16	81—35	·68	...	...	S.-W.	7	Cloudy; strong wind.
venue . .	,,	7—40	87—0	·85	...	...	W.	...	Strong wind and squally.

VESSEL.	Hour.	POSITION.		BAROMETER.			WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
		° ′	° ′						
Mount Olivet	Noon.	9—26	86—33	30·05	...	...	S.-W.	...	Occasional squalls.
Thisbe	,,	17—52	86—53	29·90	29·73	—·04	Variable	4—2	Frequent showers.
Shah Jehan	,,	19—56	87—45	29·60?	...	...	S.	...	
Frankistan	,,	20—00	88—37	·61	·72	—·04	S.-S.-E.	4	Overcast, squally with heavy rain.
Glenlin	,,	20—50	88—20	·85?	·80?	...	S.-S.-W.	4	Overcast, occasional heavy rain.
F. L. V. Planet	10 A. M.	21—15	88—11	·88	·72	—·03	S.-S.-E.	5	Moderate sea.
F. L. V. Hesperus	10 ,,	21—26	88—6	?	?	...	S.-S.-E.	4	Moderate sea, cloudy.
F. L. V. Meteor	10 ,,	20—46	87—39	·90	·74	—·01	E.-S.-E.	3	Heavy swell, overcast, rainy weather.
F. L. V. Canopus	10 ,,	21—02	88—46	·91	·74	—·01	S.	6	Overcast, squally.

These observations show that a moderately strong monsoon was blowing in the Bay, and that winds were somewhat stronger at the head of the Bay than in the south. The average wind force in the Bay during the day as calculated from all the wind observations was 4.

September 18th.—The history of the storm at this period is of peculiar interest. The storm had up to the morning of the 17th advanced in a westerly direction with unusual rapidity, and its rate of motion had increased for a short period to some extent after reaching land. In the afternoon and evening of the 17th it was, from some cause or other, unable to advance further in a westerly direction. Instead, however, of filling up it remained nearly stationary for at least 16 hours, and then recurved and advanced in an almost straight northerly course at nearly the same average rate of progression as it had previous to the 17th.

The following are the 8 A. M. observations of the 18th at selected stations:—

STATION.	BAROMETER.			WIND.			TEMPERATURE PAST 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Masulipatam	29·763	+·078	—·032	W.	9	150	91·6	—0·5	79·0	+1·0	7	—	
Secunderabad	·743	+·040	—·075	W.-S.-W	15	214	86·6	+1·5	71·4	+1·2	8	—	Strong wind.
Vizagapatam	·754	+·089	+·002	W.-S.-W.	5	125	88·4	+0·7	79·1	?	10	0·10	
Gopalpur	·721	+·071	—·014	S.	29	414	85·2	—2·3	81·8	+1·5	4	—	Sea very rough.
Cuttack	·756	+·102	+·013	S.-S.-W.	2	100	80·3	—10·1	75·8	—2·3	9	0·05	Showery.
Chyebassa	·746	+·057	?	S.-E.	3	?	84·5	?	75·8	?	10	0·10	
Hazaribagh	·737	+·039	+·005	S.-S.-E.	14	200	80·4	—4·9	71·7	—0·7	10	0·27	Squally.
Patna	·760	+·026	+·029	E.-S.-E.	11	367	90·4	—1·0	78·2	—1·6	10	0·14	
Allahabad	·646	—·003	—·063	E.	4	467	89·2	—2·1	78·6	+1·0	10	—	Strong wind.
Sutna	·604	—·006	—·097	E.	7	243	85·6	—2·2	74·1	—0·2	8	0·91	Strong wind.
Jubbulpore	·584	—·019	—·182	N.-E.	6	200	83·9	—4·9	73·1	—0·2	10	0·24	
Raipur	·626	+·071	—·094	S.	9	150	82·5	—5·3	75·6	+1·2	7	0·05	Fine.
Sambalpur	·701	+·084	—·029	S.	3	150	88·0	—1·8	77·3	+0·1	7	1·15	
Nagpur	·527	+·024	—·189	S.-S.-W.	22	440	79·2	—10·2	73·6	0	10	2·26	Severe gale of wind.

STATION.	BAROMETER.			WIND.			TEMPERATURE PAST 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual reduced to sea-level.	Change since 8 A. M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Sironcha	29·721	+·106	−·098	S.-W.	5	169	88·7	0	76·0	+0·1	8	0·17	Strong wind.
Chanda	·648	+·069	−·138	S.-S.-W.	2	50	85·1	−3·3	74·0	−0·7	10	0·15	
Seoni	·608?	+·017?	−·160?	E.-S.-E.	6	150	76·1	−9·6	71·1	−0·6	8	4·40	Raining.
Akola	·598	−·035	−·181	N.-W.	8	133	84·0	−4·5	71·7	−0·8	10	2·61	Drizzling.
Amraoti	·541	−·037	−·211	W.-S.-W.	17	425	84·1	−3·5	72·3	+0·6	10	2·64	Heavy rain.
Khandwa	·608	−·048	−·175	W.	12	200	87·2	+0·9	73·2	+0·4	10	2·37	Heavy rain.
Malegaon	·692	−·019	−·134	W.-S.-W.	15	188	91·9	+5·0	72·1	+2·3	10	1·04	
Surat	·724	−·026	−·091	S.-W.	?	?	91·6	+3·5	76·0	+0·8	4	—	Fine.
Bombay	·795	−·008	−·068	W.	16	133	84·9	+0 8	78·5	+1·9	9	0·01	
Pachmarhi	26·123	−·089	−·247	E.-N.-E.	9	150	70·9	−6·1	67·2	+0·6	10	6·27	Heavy rain.
Indore	29·616	−·052	−·177	N.-N.-W.	13	260	85·1	+1·1	71·0	+0·6	10	1·39	Strong wind.
Neemuch	·704	−·043	−·097	N.-N.-W.	9	90	89·4	+2·6	71·1	+0·8	10	0·30	
Saugor	·593	−·046	−·170	E.-N.-E.	1	33	80·8	−4·8	72·1	+1·2	10	3·68	
Nowgong	·595	−·049	−·118	E.	7	350	86·5	−3·3	73·5	−1·6	10	4·13	

A reference to the chart of the day (Plate XXIV) shows that the centre at 8 A. M. was to the north-west of Nagpur at a distance not exceeding 70 miles, and probably almost exactly midway between Betul and Chhindwara, and nearly midway between Nagpur and Pachmarhi. Hence it had not moved more than 50 miles during the previous 18 hours (since 4 P. M. of the 17th). The chart also shows that the inner area, as defined by the isobar of 29·55, was oval in shape, and that its largest diameter ran approximately north and south. The isobar of 29·60, instead of being parallel to that of 29·55 throughout the whole of its course, enclosed a considerable area to the north, in which pressure was falling rapidly, and very heavy rain was falling. This extension of the low-pressure area in a northerly direction is hence of much significance.

The barometric changes of the previous 24 hours were comparatively small in amount. This, however, was chiefly due to the fact that the low pressure or storm area had been nearly stationary. The barometer had risen rather rapidly in the eastern districts of the Central Provinces, and was falling briskly at Pachmarhi and Saugor, and perhaps Seoni (the reading actually recorded and given in the table is almost certainly wrong and should probably be 29·508). The greatest deficiency of pressure was at this time at Pachmarhi, thus showing that the storm was one of high elevation and of the rains proper rather than of the transition periods.

The depression at the centre was apparently slightly less than it had been hitherto, but still exceeded a quarter of an inch. Very strong winds continued to blow at Nagpur and Amraoti. No increase of strength was shown by the winds in Khandeish and the Bombay coast districts. Very strong easterly winds continued to prevail at Patna and Allahabad, and were now extending north-westwards to Nowgong and Jhansi. Hence the indraught to the storm area from the Bay of Bengal continued to form the chief feature of the storm.

The distribution of the rainfall of the previous 24 hours was very significant. General rain fell over the whole of Bengal, Behar, the North-Western Provinces, the Central Provinces, and Berar, the greater part of which was due to the Bay of Bengal current. Showers fell in the west coast districts, but little or no rain was received in North Bombay (including Khandeish and Guzerat), and the western districts of Central India.

The following table gives the average rainfall of the previous 24 hours in ten meteorological areas :—

PROVINCE.	Average rainfall of previous 24 hours.	Normal average daily rainfall, September.
	Inches.	Inches.
Orissa	0·37	0·46
Bengal	1·04	0·29
Behar	0·31	0·21
Central Provinces	1·18	0·31
Berar	2·63	0·20
Central India	0·93	0·24
North-Western Provinces	1·44	0·26
Rajputana	0·23	0·06
Punjab	0·06	0·06
Bombay	0·29	0·25

The distribution of heavy rainfall at this time is best shown by the following list of all rainfalls during the previous 24 hours exceeding 3 inches in amount :—

PROVINCE.	DISTRICT.	Average rainfall of districts, during previous 24 hours.	Station.	Rainfall of previous 24 hours.
North-Western Provinces.	Saharanpur	1·90	Saharanpur	5·30 inches.
	Muzaffarnagar	2·78	Bainswal	3·80 „
			Kandhla	3·70 „
	Meerut	1·73	Mawana	3·21 „
	Bulandshahr	2·56	Anupshar	5·50 „
	Bijnor	3·58	Bijnor	3·80 „
			Nagina	4·10 „
			Chandpur	4·10 „
	Moradabad	2·16	Amroha	3·90 „
	Muttra	1·05	Muttra	3·10 „
	Agra	2·01	Khairagarh	4·80 „
	Etah	2·05	Jalesar	3·60 „
	Banda	1·74	Badausa	5·60 „
	Hamirpur	2·14	Mahoba	3·12 „
	Kumaon	4·51	Pithoragarh	4·08 „
			Almora	4·50 „
			Naini Tal	13·40 „
			Haldwani	3·80 „
	Garhwal	2·30	Karnprayag	3·50 „
Central Provinces.	Saugor	2·04	Saugor	3·68 „
	Hoshangabad	2·71	Pachmarhi	6·38 „
	Betul	5·25	Multai	9·29 „
			Chicholi	7·23 „
	Nagpur	2·74	Katol	8·40 „
Berar	Berar	2·63	Akola	3·27 „
			Makhla	5·48 „
			Chikalda	6·18 „
Bombay	Bombay (West Ghâts).	2·57	Mahableshwar	4·04 „
			Baura	3·17 „

This return shows clearly that the heaviest rainfall was received at this time, and for some hours previously, in a long narrow belt running almost due north and south, or in the direction in which the storm advanced on the afternoon of the 18th.

The position of the storm centre at 4 P. M. is shown by the 4 P. M. observations given below :—

STATION.	BAROMETER.			WIND.				
	Actual reduced to sea-level.	Change since 4 P. M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Cloud proportion.	Weather.
Masulipatam	29·658	+·065	—·022	S.	11	183	8	
Secunderabad . . .	·656	+·090	—·042	N.-W.	18	257	9	
Vizagapatam . . .	·641	+·074	+·023	S.	2	50	3	Clear.
Gopalpur	·667	+·084	—·004	S.	26	371	0	Strong wind.
Cuttack	·690	+·086	+·061	S.	5	250	8	
Hazaribagh . . .	·683	+·069	+·005	S.-S.-E.	15	214	10	Passing showers.
Patna	·658	+·016	+·023	E.	10	333	7	Thunder.
Allahabad . . .	·572	+·029	—·050	E.	13	433	10	Overcast; strong wind; raining.
Sutna	·512	+·003	—·115	S.-E.	18	257	6	Strong wind.
Jubbulpore . . .	·493	—·054	—·166	?	19	633	7	Ditto.
Raipur	·548	+·088	—·063	S.-S.-W.	15	250	6	
Sambalpur . . .	·623	+·088	+·009	S.-W.	3	150	10	
Nagpur	·521	+·142	—·122	S.-W.	23	460	10	Strong wind.
Sironcha	·630	+·135	—·062	W.-N.-W.	12	400	8	Drizzling.
Chanda	.586	+·113	—·087	S.-W.	14	350	8	
Seoni	·500	+·020	—·163	S.	5	125	10	Raining.
Akola	·525	+·017	—·125	W.	17	283	10	Ditto.
Amraoti	·519	+·064	—·146	W.-S.-W.	17	425	10	Passing showers.
Khandwa	·546	+·032	—·131	W.	14	233	10	Drizzling.
Malegaon	·515	—·008	—·146	W.	29	363	10	Strong wind.
Surat	·620	+·021	—·095	S.-W.	?	?	4	
Bombay	·721	+·024	—·060	W.	16	133	5	
Pachmarhi	26·040	—·071	—·247	W.-S.-W.	11	183	10	Strong wind.
Indore	29·506	—·007	—·177	N.-N.-W.	14	280	10	Dust storm.
Neemuch	·582	—·046	—·071	N.-N.-W.	10	100	6	
Saugor	·431	?	—·242	N.-N.-E.	4	133	10	
Nowgong	·478	—·058	—·149	E.	7	350	10	
Hoshangabad . . .	·494	?	—·175	W.	1	50	10	Rain.

The 4 P. M. observations show that the depression was now commencing to move northwards. The largest fall of the barometer and the largest variation from the normal occurred at this time at Pachmarhi and Saugor, where pressure was a quarter of an inch below the normal. The wind had shifted to west-south-west at Pachmarhi,* showing that the centre of the air circulation was to the north of that station. It was, however, probably not more than 50 miles to the north of that station, and nearly midway between Saugor, Hoshangabad, and Pachmarhi. The depression was oval-shaped, with its longest diameter running north and south. The chief feature of the depression at this time was the very low pressure to the north of Pachmarhi as shown by the barometric readings at Saugor and Nowgong. The low pressure for a considerable distance in front of the centre of the cyclone circulation was hence as marked on the 18th as on the 17th. The cyclonic circulation accompanying the depression extended over the whole of Northern India, and

the North Deccan. Winds were very strong in the eastern and northern quadrants and were feeblest in the western quadrant.

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* In the chart (Plate XXIV) for this hour, the wind direction at Pachmarhi is given wrongly as north. It should be west-south-west.

19th September.—The following table gives the 8 A. M. observations at stations in and near the storm area:—

STATION.	BAROMETER.			WIND.			TEMPERATURE PAST 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Bombay	29·876	+·081	+·032	S.-W.	13	108	86·4	+2·3	79·0	+2·4	9	—	Fine.
Malegaon	·797	+·105	−·018	W.	17	213	89·4	+2·3	72·1	+1·9	10	—	Strong wind.
Akola	·753	+·155	−·005	N.-W.	8	133	82·0	−6·8	66·8	−5·5	8	1·56	
Amraoti	·758	+·217	+·012	W.-S.-W.	12	300	77·1	−11·0	71·8	+0·4	4	0·46	Showery.
Pachmarhi	26·344	+·221	+·017	W.-S.-W.	10	167	70·9	−6·4	66·2	−0·5	10	5·18	Drizzling.
Nagpur	29·753	+·226	+·0 6	S.-S.-W.	?	?	79·7	−10·2	72·6	−0·5	7	0·66	Fine.
Seoni	733	+·125	−·012	S.-S.-W.	10	250	75·1	−11·2	70·1	−0·3	6	0·39	Raining.
Jubbulpore	·686	+·102	−·054	E.-S.-E.	12	400	82·9	−5·0	72·6	−0·3	6	0·02	Strong wind.
Sutna	·693	+·089	−·021	S.-E.	15	250	87·1	−0·9	75·6	+1·1	8	0·14	Ditto.
Allahabad	·720	+·074	+·024	E.-N.-E.	13	433	87·2	−4·1	77·6	+0·1	5	0·26	Ditto.
Lucknow	7·19	+·026	+·031	E.	14	467	85·3	−5·4	77·8	+1·3	10	0·35	
Agra	·607	−·097	−·113	E.	7	175	79·1	−12·2	69·0	−6·4	9	5·88	Heavy rain.
Delhi	·676	−·068	+·009	E.	5	125	73·6	−17·8	70·6	−3·9	10	1·74	Raining.
Jeypore	·635	−·086	−·125	N.-E.	7	140	88·1	−2·6	70·0	−1·4	9	—	
Ajmere	·674	−·039	−·072	N.-W.	5	100	89·7	+0·2	68·6	−2·9	3	0·02	Distant lightning.
Jhansi	·516	−·077	−·178	E.-S.-E.	8	267	86·4	−4·0	74·9	+0·2	10	1·42	Raining.
Neemuch	·698	−·006	−·062	S.-W.	8	80	86·4	−0·7	70·1	+0·4	7	—	Fine.
Indore	·706	+·090	−·067	W.-S.-W.	10	200	79·1	−5·1	71·4	+1·2	10	0·70	
Saugor	·597	+·054	−·129	S.-S.-W.	6	200	81·3	−5·3	70·6	−0·3	10	1·10	Drizzling.
Hoshangabad	·674	+·165	−·107	W.-S.-W.	2	67	79·7	−8·8	72·7	−0·8	10	3·61	
Khandwa	·734	+·126	−·029	W.	12	200	79·2	−8·1	70·7	−1·2	9	2·36	Continuous rain.
Deesa	·721	+·042	−·063	W.	7	88	102·4	+10·5	76·8	+3·3	7	—	Fine.
Nowgong	·570	−·025	−·150	E.	6	300	86·5	−3·8	74·6	+0·1	10	0·43	Showery.

The general barometric changes of the preceding 24 hours were small in amount. Except in the storm area itself and to the north and north-west of it, the barometer was now rising slowly. The storm area at 8 A. M. included Bundelkhand, the eastern districts of Central India, south-east Rajputana, and the adjacent districts of the North-Western Provinces. The centre of the circulation at that hour was to the west-south-west of Jhansi in latitude 25¼° north, and longitude 78¼° east.* As it had been almost stationary between Nagpur, Amraoti, and Pachmarhi on the preceding day until about noon, it had moved 210 miles during the previous 20 or 24 hours, or at an average rate of 9 to 10 miles per hour. During this interval it had crossed over two ranges of hills, the Vindhyas and the Satpuras, which rise to elevations ranging up to 4,500 feet, and to heights of 1,500 to 2,000 feet above the valleys of the Tapty and the Nerbudda. It was now marching in a straight northerly course across Central India and Eastern Rajputana. It had passed through Bhopal during the night, and was advancing at 8 A. M. through the Lalitpur and Jhansi districts of the North-Western Provinces and the Gwalior State. The barometer at the centre was about 29·5″ and the depression at least two-tenths of an inch. Very strong winds were blowing at Lucknow, Allahabad,

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* In the chart for 8 A. M. of this day, Plate XXV, the wind arrow of Jhansi is, through a mistake of a draughtsman, placed too far east, and should be just included within the 29·55 isobar.

Sutna, and Jubbulpore to the north and east of the storm area. Near the centre the winds were apparently much lighter, and at stations to the north-west and west, *e.g.*, Jeypore, Ajmere, Neemuch, Indore, Hoshangabad, and Deesa, the winds were comparatively light, and in the majority of cases below the strength of the normal winds of the season. Hence the circulation was evidently maintained by indraught from the Bay of Bengal, and was apparently strongest in the north and north-east outskirts of the storm area and at distances of 200 to 300 miles from the centre. This fact is of much importance, as it not only explains the distribution of rain at this time, but also, in part, the line of march of the storm.

During the previous 24 hours, general rain had been received in Bengal, Behar, the North-Western Provinces, South-East Punjab, East Rajputana and Central India, the Central Provinces, and Berar. The following table gives the average fall of the preceding 24 hours in eight provinces :—

Province.	Actual average rainfall in Province.	Province.	Actual average rainfall in Province.
	Inches.		Inches.
Burma	0·10	North-Western Provinces	1·97
Bengal	0·25	Rajputana	0·38
Central Provinces	0·41	Punjab	0·78
Central India	0·51	Bombay	0·01

The rainfall was especially heavy to the north of the storm centre, as is shown by the following return giving all falls of 4 inches or upwards during the previous 24 hours :—

Station.	Rainfall during 24 hours previous to	
	6 P.M.	8 A.M.
	Inches.	Inches.
Pachmarhi	5·18	...
Roorkee	4·39	...
Ranikhet	4·37	...
Delhi (Cutchery)	...	5·90
Bandikui	...	4·50
Bhopal	5·00	...
Nainital	...	5·80
Saharanpur	...	8·20
Bulandshahr	...	6·20
Aligarh	...	6·86
Agra	5·88	...

The heavy rainfall caused a further rapid reduction of temperature over the Central Provinces, Central India, and the North-Western Provinces. At Meerut, Delhi, and Roorkee, the fall ranged from 8° to 10½°. Temperature continued to increase in Sind. The maximum at Jacobabad on this day was 111·3° and at Hyderabad 107·2°. Skies were more or less clouded over the greater part of India and were overcast in the storm area and to the north of it. The storm area was at this time very sharply defined to the west and north-west by t amount of cloud, as is shown by the following data:—

Station.	Amount of cloud at 8 A. M.	Station.	Amount of cl at 8 A. M.
Ludhiana	10	Patna	10
Simla	10	Calcutta	4
Delhi	10	Saugor Island	7
Sirsa	8	Murree	0
Jeypore	9	Lahore	0
Lucknow	10	Mooltan	0
Allahabad	5	Ajmere	3

The following table gives the 4 P. M. observations at stations in and ne the storm area:—

Station.	Barometer.			Wind.			Cloud proportion.	Weather.
	Actual reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Bombay	29·823	+·102	+·065	W.-S.-W.	8	67	10	
Malegaon	·711	+·188	+·048	W.	21	263	10	
Akola	·699	+·178	+·055	N.-N.-W.	10	167	8	
Amraoti	·712	+·197	+·967	W.-S.-W.	11	275	8	
Pachmarhi	26·355	+·315	+·080	W.-S.-W.	6	100	8	
Nagpur	29·701	+·187	+·068	S.-W.	?	?	6	
Seoni	·679	+·192	+·035	S.	14	350	5	
Jubbulpore	·669	+·172	—·030	S.	14	467	8	Strong wind.
Sutna	·684	+·158	+·051	W.-S.-W.	18	300	6	
Allahabad	·640	+·070	+·027	S.-E.	10	333	7	Cloudy; strong wi
Lucknow	·676	+·061	+·055	N.-N.-W.?	17	567	10	Rainy; strong wi
Agra	·460	—·155	—·178	S.-E.	16	400	10	
Delhi	·552	—·125	—·062	E.	20	500	10	
Jeypore	·560	—·058	—·118	N.	7	140	10	Drizzling.
Ajmere	·568	—·003	—·074	N.-W.	14	280	5	
Jhansi	·556	+·066	—·065	S.	17	567	10	Drizzling.
Neemuch	·647	+·053	+·002	S.-W.	18	180	8	
Indore	·665	+·156	—·004	W.-S.-W.	11	220	9	
Saugor	·656	+·206	—·026	S.-S.-W.	15	500	10	
Hoshangabad	·633	+·145	—·033	S.-W.	11	367	8	
Khandwa	·707	+·165	+·032	W.	?	?	7	
Deesa	·617	+·086	—·022	W.-S.-W.	14	175	5	
Nowgong	·611	+·131	—·016	S.-W.	9	450	10	Strong wind.

These observations show that the centre had advanced in a due northe direction and was probably in Lat. 26½° N. to 26¾° N. and in Long. 77¾° to 78° It had hence advanced about 120 miles during the previous eight hours, or at average rate of about 15 miles, and hence nearly the same as during its passa across the Bay and Orissa into the Central Provinces.

Skies were now clearing in the Central Provinces, Berar, and Central Indi but strong westerly winds continued to prevail. Skies were very densely cloud in the North-Western Provinces and overcast in Bengal and Behar, and ve strong winds prevailed over the whole of the Gangetic plain. As hitherto, win were strongest near and to the north of the centre. Jhansi, Agra, Delhi, a Roorkee reported on this day winds of more than four times their norm strength. It continued to rain excessively over the central area and the di tricts to the north towards which it was advancing. A well-defined cyclon circulation prevailed over the whole of the storm area. The chief indraught moist winds continued to be from the Bay of Bengal in the eastern and northern quadrants. The cloud area extended over the whole of Northern India from Bengal to the storm area, and was very sharply defined in the Punjab, where to the north and west of Lahore fine clear weather obtained.

20th September.—The following table gives the 8 A. M. observations at stations in and near the storm area:—

STATION.	BAROMETER.			WIND.			TEMPERATURE PAST 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Indore . .	29·920	+·214	+·131	S.-W.	9	180	84·6	—1·2	69·5	—0·6	9	—	
Neemuch .	·983	+·185	+·118	S.-W.	21	210	90·4	+2·5	70·1	+0·5	7	—	Fine.
Saugor . .	·849	+·252	+·122	W.-S.-W.	8	267	78·8	—7·9	71·6	+1·4	3	0·22	Fine.
Allahabad .	·851	+·131	+·143	S.	6	200	90·7	—0·7	77·1	+0·5	5	0·30	
Lucknow .	·853	+·134	+·137	N.-N.-W.?	12	400	85·3	—6·7	75·8	—0·2	10	1·03	
Nowgong .	·831	+·261	+·102	W.-S.-W.	6	300	81·0	—9·9	73·0	—0·6	3	0·20	Fine.
Jhansi . .	·789	+·273	+·080	S.-W.	12	400	78·4	-13·1	72·4	—1·7	3	1·12	Raining.
Ajmere . .	·801	+·127	+·036	W.	11	220	86·2	—3·1	73·6	+2·0	9	....	Fine.
Jeypore . .	·782	+·147	+·016	N.-W.	11	220	78·0	-12·7	71·5	+0·7	10	0·35	Drizzling.
Agra . .	·761	+·154	+·049	S.-W.	12	300	81·6	-10·9	75·0	—0·1	9	1·08	Showery.
Bareilly . .	·802	+·098	+·115	E.-S.-E.	15	500	83·3	—7·7	76·3	+0·6	10	1·05	Squally.
Delhi . .	·647	—.031	+·015	W.	7	175	77·1	-15·3	74·1	—0·8	10	6·05	
Sirsa . .	·682	—·048	0	N.-N.-W.	13	325	79·0	-17·9	70·2	—3·0	10	0·74	Strong wind.
Meerut . .	·627	—·072	+·009	E.	8	400	80·2	-11·8	73·9	+0·7	10	5·15	Raining.
Roorkee . .	·673	—·081	—·026	S.-E.	5	250	72·8	-18·1	68·2	—3·8	10	7·20	Heavy rain.
Ludhiana .	·722	—·025	—·022	N.-N.-E.	6	600	84·2	—7·9	68·0	—4·8	10	3·52	Raining.
Lahore . .	·716	—·025	+·027	N.	5	250	91·1	—4·3	70·4	—2·2	5	...	Fine.
Mooltan . .	·753	+·085	+·052	S.-W.	1	33	?	?	?	?	0	...	
Chakrata .	23·160	—·051	—·037	E.	14	280	57·8	—10·5	53·3	—2·9	10	1·98	
Simla . . .	·127	—·063	—·106	N.-W.	?	?	61·3	—8·3	52·4	—3·2	10	3·32	Continuous rain.
Murree .	·793	—·020	—·010	N.-W.	6	120	75·6	+3·4	56·3	—0·7	0	—	

The general rise of the barometer continued over the whole of India. In Central and Upper India this small general change was supplemented by the much larger changes due to the advance of the cyclonic storm. The barometer had fallen rapidly in the south-east Punjab and western districts of the North-Western Provinces and risen even more rapidly in the Central Provinces and Central India.

The centre of the storm was at 8 A. M. a few miles to the south of Meerut in about Lat. 29° N. and Long. 77°45′ E. It had hence advanced about 280 miles during the previous 24 hours, or with an average velocity of 12 miles per hour. The storm centre was now not more than 90 miles in a direct line from the hills. The northern outskirts of the storm already extended into the Himalayan hill districts, and hence the circulation in the northern quadrant began to be obstructed by the hills. This had already caused the depression to begin to fill up. The height of the barometer at the centre at 8 A. M. was 29·6″, and the depression below the normal at the plain stations in the storm area very small in amount, not exceeding ·02″ or ·03″. The barometric observations at the hill stations are not only interesting but confirm the inference based on the great deficiency of pressure at Pachmarhi as compared with that at the adjacent plain stations (*vide* page 174).

The storm was advancing almost directly to the Simla hills. At 8 A. M. the barometer at Simla was ·11" below the normal, while at Ludhiana it was only ·02". The deficiency at Chakrata was also greater than at Roorkee. Hence the depression at this stage of the storm, as when it was in the Central Provinces, was actually greater at an elevation of 4,000 to 7,000 feet than it was in the lowest strata. This was hence probably a feature of the storm throughout the whole of its existence.

The chief feature of the air motion during the previous 24 hours was the very strong easterly winds which fed into the storm. Thus at Ludhiana, Meerut, Bareilly, Roorkee, and Lucknow the winds during the preceding 24 hours were from three to six times their normal strength. In the west and south-west quadrants the winds averaged about two times their normal force. The Meerut and Delhi wind observations appear to establish that the air motion near the centre was actually less in amount than in the outskirts of the storm. This is further confirmed by contrasting the wind velocity at Jhansi on the 19th (8 miles per hour) with that of the 20th (12 miles per hour). This, in fact, appears to have been a characteristic feature of the storm throughout its existence on land.

The rainfall of the previous 24 hours was confined almost entirely to the North-Western Provinces and South-East Punjab. The following table gives the average rainfall in nine provinces :—

PROVINCE.	Actual average rainfall of previous 24 hours.	PROVINCE.	Actual average rainfall of previous 24 hours.
	Inches.		Inches.
Burma	0·10	Central India	0
Bengal	0·08	Rajputana	0·05
Assam	0·37	Punjab	1·03
North-Western Provinces	1·45	Bombay	0·01
Central Provinces	0		

The rainfall was specially heavy in front of the advancing storm. The following gives rainfalls exceeding 5 inches during the previous 24 hours :—

DISTRICT.	Station.	Rainfall during previous 24 hours.	DISTRICT.	Station.	Rainfall during previous 24 hours.
		Inches.			Inches.
			Simla	Kasauli	9·50
Delhi	Delhi	5·80		Barauli	5·60
Karnal	Karnal	5·50		Kot Khai	5·20
	Kaithal	5·90		Kotgarh	5·20
			Jullundur	Nawashahr	5·70
Umballa	Pipli	6·80	Ludhiana	Samrala	9·00
	Jagadhri	9·40	Saharanpur	Roorkee	9·50
	Umballa	8·40		Nakur	7·50
	Naraingarh	7·40		Deoband	5·90
	Kharar	10·30		Hardwar	7·50
	Rupar	9·30		Muhammedpore	7·50
				Niashahr	8·[illegible]

Skies were now clearing rapidly in the Central Provinces and Central In
The storm area, as on the 19th, was very sharply defined in the western quadr

by the cloud canopy. This is partially shown by the following data of cloud amounts:—

STATION.	Amount of cloud at 8 A.M.	STATION.	Amount of cloud at 8 A.M.
Sirsa	10	Patna	0
Ludhiana	10	Calcutta	4
Simla	10	Saugor Island	4
Mooltan	0	Lahore	5
Lucknow	10	Sialkot	0
Allahabad	5	Murree	0

The following gives 4 P. M. observations at stations in and near the storm area:—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Indore	29·824	+·162	+·154	W.-N.-W.	7	140	5	
Neemuch	·850	+·194	+·178	S.-W.	21	210	4	
Saugor	·808	+·162	+·136	W.-N.-W.	25	833	1	
Allahabad	·788	+·149	+·156	W.-S.-W.	2	67	3	
Lucknow	·812	+·140	+·170	N.-N.-W.	5	167	6	
Nowgong	·800	+·194	+·141	W.	4	200	2	
Jhansi	·767	+·270	+·114	S.-W.	7	233	3	Misty.
Ajmere	·840	+·271	+·060	W.	14	280	1	
Jeypore	·829	+·253	+·096	W.-N.-W.	11	220	10	
Agra	·810	+·346	+·151	S.-W.	8	200	9	Drizzling.
Bareilly	·774	+·151	+·145	W.-S.-W.	8	267	10	
Delhi	·768	+·218	+·145	W.-S.-W.	1	25	9	Raining.
Sirsa	·714	+·058	+·084	N.-E.	12	300	8	
Meerut	·766	+·159	+·139	S.-W.	7	333	10	
Roorkee	·786	+·129	+·152	S.-E.	18	900	10	
Ludhiana	·717	—·047	+·046	N.	2	200	10	Overcast.
Lahore	·696	—·013	+·067	S.	5	250	0	Strong wind.
Mooltan	·654	+·098	+·045	S.-W.	2	67	0	Clear.
Chakrata	23·174	—·039	+·004	E.	18	360	10	Raining.
Simla	·102	—·054	—·098	E.	?	?	10	Raining.
Murree	·825	+·015	+·034	S.-E.	9	180	4	

The 4 P. M. observations (charted in Plate xxvi) establish that the depression had disappeared and that pressure was lowest in the North-West Punjab. The depression had hence continued to advance towards the hills and been broken up. It had given rise to a moderate fall of the barometer at Simla, but this ceased during the night of the 20th and the barometer began to rise rapidly on the morning of the 21st. The wind directions at Roorkee, Meerut, Delhi, Ludhiana, and adjacent stations show that the cyclonic circulation was not yet completely broken up. Strong south-east and east winds continued to blow for some hours afterwards, but they fell off rapidly in strength during the night. Skies were still overcast in the South-East Punjab and adjacent districts of the North-Western Provinces and Rajputana, but were clear or lightly clouded in other districts of Northern and Central India. The influence of the storm

appears to have extended to a considerable distance into the hills and was certai
ly felt up to the first line of snows in Kulu. At Kailang in Kulu upwards of
inches of rain were registered during the month, nearly the whole of which fe
on the 20th and 21st. The average rainfall of the month is only 1·15 inche
So heavy a rainfall had not been experienced in that month during the previo
twenty-five years. It may also be noted that at Leh, the sky, which had bee
clear for some time, clouded over on the afternoon of the 19th, and did not cle
again until the morning of the 21st. It is very probable, if not certain, that th
was due to the cyclonic storm in Northern India, and hence that the influen
of the storm extended across the Punjab Himalayas into Ladakh.

CHAPTER III.

Account of the Cyclone of October 27th to 31st in the Bay of Bengal, and of the Cyclone of November 6th to 9th in the Arabian Sea.

Brief statement of the weather in India during the interval between the first and second storms.—After the breaking up of the storm described in the preceding pages, fine dry weather set in over the whole of Upper and Central India. The conditions in Burma throughout the whole season had been abnormal, the chief feature being persistent low pressure as compared with the normal, and also with that prevailing in adjacent districts. This feature continued after the disappearance of the previous storm. A depression began to form on the 1st of October to the south-west of Diamond Island. It advanced first to the north-west, but recurved through north to north-north-east before it reached the coast at the head of the Bay. It crossed the coast of the Sunderbunds a little to the east of Saugor Island on the evening of the 6th, and advanced into Central Bengal, where it filled up during the night of the 7th. It was of very small extent but of considerable intensity, and several vessels near the head of the Bay experienced winds of hurricane force. A longish interval of fine dry weather followed. The peculiar conditions in Burma again came into prominence. The persistent low pressure conditions in that area were for some time antagonistic to the establishment of the north-east monsoon on the Madras coast, but they gradually became less marked, and finally on the 22nd pressure began to increase in Burma and decrease in Southern India. Previously to this important change, pressure was from a twentieth to the tenth of an inch lower in Burma and the east of the Pay than in the Peninsula, but on the 23rd it was very uniform over the whole of the Bay and in Burma. The fall of the barometer continued in the Peninsula and over the south and south-west of the Bay, the result being that the pressure conditions in the Bay were reversed and moderate gradients favouring the setting in of north-east winds on the Coromandel coast were established on the 25th and following days. These winds gave frequent showers for some days in the Carnatic-Ganjam, and the Circars had received unusually scanty supplies of rain during the previous four or five months, and the diversion of the rain-giving current accompanying the change of gradients in the Bay to the Coromandel coast threatened those districts with the continuation of drought at a most critical time. Fortunately a depression or cyclonic storm began to form on the 27th and 28th to the south-west of the Andamans, which gave these districts a period of abundant rain. This is the storm we have now to describe.

The corrections of the barometers on board the vessels which took observations during the stormy weather in the Bay of Bengal and Arabian Sea, and which are utilized in the following account of the storms, were determined in the manner stated in page 139.

The following table gives the corrections as thus determined which are applied to the readings of the barometers of the vessels in the Bay of Bengal to make them comparable with the readings of the land observatories :—

	Correction.		Correction.
S. S. Medea	**—·05**	***Ship Glengarry***	**+·09**
S. S. Arracan	**—·11**	***Ship Castle Roy***	**—·13**
Ship Lock Torridon	**—·06**	***Ship Queen of Scots***	**—·10**
Ship Victoria Regina	**—·06**	***Ship Evesham Abbey***	**—·09**
S. S. Maharani	**+·06**	***S. S. Shah Jahan***	**—·29**
Ship Dovenby Hall	**+·22?**	***Ship Gilroy***	**—·01**
S. S. Akbar	**+·07**	***S. S. Duke of Argyll***	**—·01**
S. S. Kistna	**—·07**	***Ship Sierra Miranda***	**—·14**
S. S. Ethiopia	**+·09**	***S. S. Goorkha***	**—·05**
S. S. Chupra	**+·02**	***S. S. Culna***	**0**
S. S. Khedive	**0**	***Ship Foyle***	**—·14**
Ship Andora	**—·10**	***S. S. Peshwa***	**—·08**
Ship City of Calcutta	**+·14**	***S. S. Mount Tabor***	**—·22**
S. S. Rajputana	**0**	***S. S. Kohinoor***	**0**

Some of the barometric observations furnished by these vessels are very doubtful. It is not possible to state with certainty whether this was due to the use of faulty instruments, or to incorrect readings of the instruments. The barometric observations of the *Dovenby Hall* and *Foyle*, for example, are, from one of these causes, very doubtful and of little value.

The following gives the corrections of the barometers of the vessels the observations of which are utilized in the discussion of the stormy weather in the Arabian Sea :—

VESSEL.	Correction adopted by the Calcutta Office.	Correction determined by comparison made by Bombay Meteorological Office.	VESSEL.	Correction adopted by the Calcutta Office.	Correction determined by comparison made by Bombay Meteorological Office.
S. S. Lombardy	+·38	+·495	*S. S. Assyria*	—·05	—·027
S. S. Canara	—·06	—·092	*S. S. Henzada*	—·05 to *nil*	+·16
S. S. Dalhousie	—·14	0	*S. S. Arabia*	—·16	—·035
S. S. Graham	—·07	+·066	*S. S. Husara*	—·24	—.195
S. S. Idar	+·13	+·188	*S. S. Patna*	—·12	...
Ship Columbus	+·38	+·380	*S. S. Lalpura*	—·07 to—·11	—·018
S. S. Busheer	*Nil.*	— 007	*S. S. Baghdad*	—·15	+·096
Ship Castor	—·02	—·014	*S. S. Berenice*	—·17	—·179
S. S. Drumbarlie	—·01	—·012	*S. S. Arcadia*	—·12	+·031
S. S. Inchborva	+·04 to +·15	+·042	*S. S. Loodiana*	—·03	+·037
S. S. Serapis	—·14	—·008	*S. S. Calder*	*Nil.*	—·055
S. S. Apollo	—·07	...	*S. S. H. Bolckow*	*Nil.*	+·023
S. S. Clyde	—·06	+·092	*S. S. Commilla*	—·12	—·193
S. S. Pachumba	*Nil.*	—·021	*S. S. Hampstead*	+·55	+·618
S. S. City of Canterbury	—·23	—·228	*S. S. Oriental*	—·13	+·115
S. S. Mishowen Head	—·08	+·296	*Ship Manora*	0 to +·15	...

The observations taken on board the following vessels cannot be reconciled with those of other vessels and by the use of a single correction. The instruments were either more or less defective or some of the observations incorrectly taken. In a few cases there were apparently more than one barometer in use, the errors and corrections of which differed very considerably. The readings

en from these instruments were mixed together and entered in the logs as if y were taken from one instrument only.

VESSEL.	Correction.	Correction determined by comparison made by Bombay Meteorological Office.
S. S. Nurjahan . .	Variable; average —·06	—·103
S. S. Othello . . .	—·23 to —·35	—·230
S. S. Lawada . . .	*Nil* to —·13	+·083
S. S. Purulia . . .	*Nil* to —·06	+·066
S. S. Siam . . .	—·10 to —·20	—·044
S. S. Imperator . .	+·12 to +·23	+·125
S. S. Yesso . . .	—·10	—0.351
S. S. Taif . . .	Very doubtful; average about —1·39	—1·385
S. S. Coconada . .	+·03	+·082

October 26.—The following gives the meteorological data for the coast sta-ıs at 8 A.M. for the 26th:—

TATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
gui . .	29·973	—·006	+·030	N.-N.-E.	2	200	89·1	+1·6	68·0	—4·8	7	—	
y . .	·992	—·018	?	N.-E.	4	?	88·2	?	70·2	?	8	—	
goon .	30·060	—·009	+·105	N.-E.	5	167	89·0	+1·2	75·4	+0·4	0	—	
Blair .	29·986	—·042	+·070	E.	5	83	89·0	+2·6	77·9	+0·1	4	—	Misty.
ond Island	30·031	—·007	+·069	E.-N.-E.	11	183	88·3	+2·2	76·0	—0·3	4	—	Fine.
ab . .	·050	—·025	+·104	N.-N.-W.	3	150	89·7	+3·3	77·6	+2·3	0	—	
agong .	·082	—·023	+·125	N.-N.-E.	1	33	88·6	+4·6	70·0	—0·6	0	—	
or Island .	·077	—·042	+·139	N.	6	86	88·2	+2·8	73·0	—0·9	1	—	Sea smooth.
Point .	·081	—·012	+·130	N.	6	100	87·0	+0·3	71·7	+0·9	0	—	
lpur .	·072	—·017	+·152	N.-W.	11	183	87·2	?	78·3	?	3	0·03	Sea smooth.
gapatam .	·059	—·001	+·089	N.	1	50	85·9	0	79·1	—0·8	5	0·10	Fine.
nada .	·031	+·002	?	N.-E.	16	?	85·0	?	76·6	?	1	—	Sea slight.
lipatam .	·041	+·016	+·114	N.-N.-E.	5	125	89·5	+0·5	75·1	+0·2	7	0·17	
re . .	·019	—·001	?	S.-W.	?	?	83·3	?	74·6	?	10	1·59	
ras . .	·029	+·051	+·103	N.-E.	5	100	84·5	—3·8	75·0	+0·9	9	1·15	
patam .	29·993	—·002	+·063	E.	4	100	82·9	—3·4	74·2	—0·2	10	4·33	Sea rough.
comalee .	·968	+·002	+·018	Calm.	4	60	84·5	?	74·0	?	5	3·60	
mbo .	·964	+·010	+·017	S.	6	57	85.5	?	73·0	?	8	1·52	Fine.

The history of the storm commences with the 26th, because although the d observations give absolutely no indication of bad weather, the logs of ships w that the unsettled weather in the Bay of Bengal which gradually developed) the cyclone commenced on that day. Pressure was decreasing at this time over the whole of India and was very uniform in North-Eastern India. The following data show approximately the limits of the area of uniform pressure:—

	Pressure. 8 A.M.		Pressure. 8 A.M.
Akyab	30·050	Akola	30·057
Calcutta	·081	Secunderabad	·079
Lucknow	·088	Allahabad	·080
Indore	·064	Cuttack	·086

It hence extended over nearly the whole of Northern and Central India. Fine dry weather, with clear or lightly clouded skies and light unsteady winds, prevailed generally in Northern and Central India. On the other hand pressure decreased from north to south in the Peninsula and Bay of Bengal, and moderately steep gradients favouring north-east winds were established. Light to moderate showers were falling at this time in the Madras coast districts south of Ganjam and over the whole of the Peninsula south of Lat. 16° N. The following gives the average rainfall of the previous 24 hours and the heaviest rainfalls in each district of the Madras Presidency:—

DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.	DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.
	Inches.	Inches.		Inches.	Inches.
Chingleput	2·83	3·50	Cuddapah	0·50	0·80
Arcot (South)	2·32	3·00	Madura	0·46	0·66
Tanjore	2·12	4·33	Nilgiris	0·32	0·32
Tinnevelly	1·97	2·30	Malabar	0·30	0·60
Madras	1·55	1·55	Anantapur	0·22	0·44
Canara (South)	1·52	1·52	Kistna	0·17	0·33
Nellore	0·88	1·15	Vizagapatam	0·06	0·45
Coimbatore	0·66	0·96	Bellary	0·03	0·06
Salem	0·64	0·90	Ganjam	0·01	0·03
Trichinopoly	0·58	0·58	Godavari	0	0
Arcot (North)	0·50	0·80	Kurnool	0	0

The table shows that the rainfall was scanty in North Madras, and moderately heavy in Central and South Madras. It was especially heavy in the Tanjore, Tinnevelly, Chingleput, and South Arcot districts at this time.

The following table gives a brief summary of the information contained in the logs of the vessels in the Bay of Bengal on this day—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
City of Calcutta	6—0	81—2	29·84	29·98	+ .05	S.-E.	4	Moderate breeze and showery.
Medea	Colombo	Harbour	30·03	29·98	+ ·06	W.	3	Cloudy. Raining in afternoon.
Loch Torridon	7—18	91—50	29·99	·93	+ ·01	W.-N.-W. to N.	...	Light, variable, baffling winds all day. Thick cloudy weather.
Victoria Regina	7—42	89—17	30·00	·94	+ ·04	N.-W.	...	Light winds and heavy rain-squalls.
Arracan	7—40	83—30	30·08	·97	+ ·06	S.-E. by S.	4	Dull cloudy weather with occasional rain-squalls.

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Dovenby Hall	7—58	89—30	29·90	?	?	E.	4	Light to moderate breezes; squally, with constant rain.
Maharani	8—32	93—32	29·90	29·96	+·04	E.	4	Squally, with heavy rain.
Sierra Miranda	8—49	90—45	30·18	·94?	+·03?	N.-E.	1	Light variable airs and heavy rain.
Akbar	8—25	82—51	29·98	·97	+·06	E.-S.-E.	2	Showery.
Kistna	8—51	82—59	30·08	30·01?	+·11?	S.-E.	4	Squally, with rain; confused sea all day.
Ethiopia	10—30	80—43	29·90	29·99	+·10	E.	3	Squally; very cloudy; much rain.
Duke of Argyll	11—30	83—50	30·02	·98	+·10	E.	2	Cloudy and passing squalls.
Chupra	12—19	84—42	29·96	·98	+·10	E.-N. E.	6	Squally, easterly swell.
Khedive	13—10	80—21	29·95	·95	+·07	E.-N. E.	3	Squally; heavy rain.
Andora	13—28	90—57	30·11	30·01	+·10	E.-N. E.	4	Moderate wind and fine.
Glengarry	13—36	90—41	29·88	29·97	+·06	E. by N.	...	Moderate breeze; squally.
Castle Roy	13—50	87—18	30·12	·99	+·12	N.-E. by E.	5	Squally, with rain.
Queen of Scots	14—11	91—20	·10	30·00	+·10	E.-N. E.	5	Moderate wind and fine.
Evesham Abbey	14—24	87—46	·10	·01	+·14	E.	3	Squally.
Shahjahan	16—10	96—12	...	...	...	N.-E.	3	Fine clear weather.
Edmonton	16—39	86—04	...	...	...	N.-E.	..	Fine clear weather all day.
Foyle	17—54	90—53	·20	·06	+·18	N.-E.	4	Ditto ditto.
Gilroy	18—56	88—02	·05	·04	+·17	E -N.-E.	4	Moderate wind; fine clear weather.
Culna	18—57	90—44	·05	·05	+·17	N. by E.	3	Moderate wind; sea smooth.
F. L. V. Meteor	Ridge Light station Sandheads.		·25	·08	+·18	N.	1	Sea smooth.
F. L. V. Planet	Intermediate station.		·24	·07	+·17	N.	2	Ditto.
F. L. V. Canopus	Mutla station, Sandheads.		·23	·08	+·18	N.-N.-E.	1	Very slight southerly swell.

The preceding data are sufficient to enable the weather in the Bay of Bengal at this time to be fully determined.

In the Bay to the north of Lat. 16° N. fine clear weather prevailed with steady north-east winds, strongest in the south and weakest near the Bengal coast. This is proved by data given by eight vessels including three light vessels.

Over nearly the whole of the Bay to the south of Lat. 16° N. the weather was slightly unsettled and squally. The character of the weather in the western half of this area differed considerably from that over a portion of the eastern half lying to the south-west of the Andamans. The logs of fourteen vessels show that in the former area, frequent rain-squalls accompanied the north and east winds which prevailed, and that these winds were unusually strong and steady.

The winds were of force 4 to 6, the last being observed on board the ***Chupra*** Lat. 12° 19′ N. and Long. 84° 42′ E. As already stated, frequent showers w falling at this time in the coast districts. The weather in the south-west of Bay and the adjacent coast districts was hence such as usually prevails dur a strong burst of the so-called north-east monsoon (and really the retreat south-west monsoon).

In the area defined by the parallels of 6° N. and 12° N. and the meridian 88° and 92° E. the weather was also squally, but the squalls were more sev than further to the west, and accompanied very variable winds and almost const rain. As this area was the birth-place of the cyclone, the full data of the ships which were traversing it immediately before its formation are of great terest. The observations taken on board these vessels on the 26th are gi below:—

VESSEL.	Hour.	POSITION AT NOON.		BAROMETER.		WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Direction.	Force.	
Loch Torridon	4 A.M.			29·96	29·90	N.-E. to S.-S.-W.	3	Thick weather.
	8 A.M.			30·05	·99	Variable.	0 to 3	Light baffling win
	Noon.	7°-18′	91°-50′	29·99	·93	W.-N.-W. to N.	4	
	4 P.M.			·93	·87	W.-N.-W.	2 to 3	Light winds.
	8 P.M.			·99	·93	W.-N.-W.	1	Light airs.
	Mid.			·97	·91	W. to S.-E.	1	Ditto.
Dovenby Hall	4 A.M.			?		S.-E.	4	Moderate breeze.
	8 A.M.			·85		S.	4	Squally, with co stant rain.
	Noon.	7°-58′	89°-30′	·90		E.	4	
				·75		N.-E. by E.	2	
	4 P.M.						2	
						N.-N.-E.	2	Light breeze; squally.
	8 P.M.							
	Mid.					N.-W.	3	
Victoria Regina	Noon.	7°-42′	89°-17′	30·00	29·94	N.-W.	...	Light and varia winds and hea rain; squalls at tervals during whole day.
Sierra Miranda	4 A.M.			·95		E.-N.-E.	3	Light breeze.
	8 A.M.			30·02		E.-S.-E.	2	
	Noon.	8°-49′	90°-45′	·02		N.-E.	1	Light variable a and heavy rain.
	4 P.M.			29·96				
	8 P.M.			30·02		N. by W.	2	Ditto.
						N.-N.-E.	1	Light variable a and lightning.
	Mid.			30·00		E.	3	Light breeze.
Maharani	4 A.M.			29·90	29·96	E.	2	Fine weather; ov cast.
	8 A.M.			·90	·96	E.	3	Fine weather; hea clouds.
	Noon.	8°-32′	93°-32′	·90	·96	E.	4	Squally, with hea rain.
	4 P.M.			·86	·92	E.	4	Fine weather.
	8 P.M.			·93	·99	E.	4	Ditto.
	Mid.			·92	·98	E.	3	Ditto.

The preceding data establish that the wind observations in this part of the y stood in marked contrast to those taken on board ships in the rest of, the Bay. e most remarkable feature of the meteorology of this area was the variability he winds. They were also, as might be expected, much lighter than in any er part of the Bay. This is best shown by the average of all the observations orded for the three divisions of the Bay which are given in the following le :—

—	Actual average force of wind.	Normal force, October.
North of Bay to north of Latitude 16° N.	3·1	2·7
South of Bay to south of Latitude 16° N. and west of Longitude 88° E.	3·7	3·4
South-east of Bay, *i.e*,, south of Latitude 16° N., and east of Longitude 88° E. or, area of variable winds	2·6	3·2

The estimate of wind strength is, of course, not exact on board ships. The ults given above, however, are quite consistent and probably represent very roximately the strength of the winds in the three divisions of the Bay inated above.

The observations also show that the area of light variable winds was one of vy and almost constant rain during the day. Thus the *Victoria Regina* had quent heavy rain-squalls, the *Dovenby Hall* had constant rain, the *Maharani* l *Sierra Miranda* had heavy rain, and the *Loch Torridon*, which was in the tre of the area, had thick weather, light baffling winds, and constant heavy n.

The observations of the day hence establish that the chief features of the ather in this area were—

(*a*) Light variable winds.

(*b*) Squally weather with much rain.

(*c*) Absence of marked barometric depression. A belt or trough of minimum pressure ran across the Bay from the Nicobar Islands to the Malabar Coast. There was a very shallow depression in the trough in the Arabian Sea off the Malabar Coast, and a tendency towards another to the west of the Nicobars.

(*d*) Steady north-east winds to the north and west, north-east to east winds to the east, and south-east winds to the south of the area of light variable winds. There was as yet no indication of the establishment of a cyclonic circulation in or near the area of variable winds.

October 27th.—The meteorological data for coast stations for 8 **A.M.** of 27th are as follows :—

STATION.	BAROMETER.			WIND.			TEMPERTURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weat
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Mergui . .	29·959	—·014	+·017	N.-N.-E.	2	200	87·1	—1·4	64·5	—7·9	5	—	Cloud
Tavoy . .	·952	—·040	?	N.-E.	3	?	85·7	?	64·2	?	2	—	
Rangoon . .	30·013	—·047	+·010	N.-E.	5	167	87·5	—0·1	71·9	—2·9	6	—	Fine.
Port Blair .	29·948	—·038	+·024	S.-E.	7	117	90·0	+3·1	79·9	+1·9	4	—	Misty.
Diamond Island	·983	—·048	+·029	E -N.-E.	6	100	87·9	+1·5	76·0	—0·1	4	—	Fine.
Akyab . .	·986	—·064	+·024	E.-N.-E.	3	150	90·2	+2·2	77·1	+1·8	0	—	
Chittagong .	30·001	—·081	+·055	Calm.	1	33	88·1	+2·6	69·5	—1·6	10	—	Foggy
Saugor Island .	·011	—·066	+·059	N.	7	100	87·2	+2·1	71·0	—1·9	1	—	Sea s
False Point .	·004	—·077	+·053	N.-N.-W.	6	100	87·9	+1·4	79·2	+8·9	0	—	
Gopalpur .	·016	—·056	+·043	N.	10	167	87·7	?	76·8	?	1	—	Dit
Vizagapatam .	·003	—·056	+·058	N.	1	50	87·4	+2·5	80·1	+0·4	4	—	Fine.
Coconada .	29·973	—·058	?	N.-N.-E.	14	?	85·5	?	76·6	?	4	—	Slight
Masulipatam .	·977	—·064	+·046	N.-E.	11	275	91·1	+3·1	74·6	+0·4	9	—	
Nellore . .	·973	—·046	?	N.-W.	?	?	88·7	?	76·1	?	10	—	
Madras . .	·965	—·064	+·020	N.-N.-W.	4	80	83·5	—3·8	76·0	+1·6	10	1·02	Drizz
Negapatam .	·925	—·068	0	N.-W.	4	100	83·4	—0·8	74·2	—0·6	7	1·50	Sea r
Trincomalee .	·920	—·048	?	S.-W.	5	50	87·0	?	74·0	?	9	0·32	
Colombo .	·924	—·040	—·018	Calm.	4	57	85·0	?	74·0	?	8	0·13	Threa

Pressure had decreased during the previous day over the whole of Indi decrease being greatest in the Punjab and least on the Malabar coast and i south of the Peninsula. These changes tended further to equalize pressure. following data show approximately the area over which this feature of uni pressure prevailed :—

	Pressure at 8 A.M.			Pressure at 8 A.M.	
Rangoon . .	30·013	Inches.	Lahore . .	30·010	Inches.
Saugor Island .	·011	„	Gopalpur . .	·016	„
Benares . .	·011	„	Bellary . .	·016	„
Allahabad . .	·010	„	Coimbatore .	·013	„
Bareilly . .	·012	„	Hoshangabad .	·006	„

It hence included the whole of Northern and Central India. Pressure was everywhere above the average, the excess being greatest in the north o Bay, Bengal, and Orissa. Hence moderate gradients obtained in the Bay, fa ng the continuance of stronger north-east winds than usual.

The chart of the 27th (see Plate XXIX) is given to show the pressure wind conditions which prevailed on that day. Winds were even lighter ove whole of Northern and Central India than on the 26th, and the air was some drier. Rain fell very generally over the whole of the Peninsula to the sou 16° N. Lat. Moderate rain was received in South and Central Madras, Ce Malabar, and Arracan, and light showers in the North Deccan and Khand he average rainfall in each district of the Madras Presidency during the us 24 hours is given in the following table:—

DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.	DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.
	Inches.	Inches.		Inches.	Inches.
lly	2·87	6·40	Nellore	0·41	0·65
	0·93	1·50	Malabar	0·33	1·00
	0·87	2·10	Arcot, North	0·20	0·72
	0·84	0·84	Coimbatore	0·13	0·20
poly	0·84	1·10	Vizagapatam	0·03	0·25
put	0·75	1·40	Ganjam	0	0
outh	0·73	1·05	Godavari	0	0
South	0·72	0·72	Kistna	0	0·01
ah	0·55	1·10	Kurnool	0	0
	0·47	1·25	Bellary	0	0
	0·45	0·45	Anantapur	0	0

he following gives the noon observations of the 27th taken on board ships Bay of Bengal:—

ESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
	6—17	81—04	29·86	29·93	0	S.-S.-W.	2	Fine.
Argyll	8—51	82—35	·91	·90	0	S.	0 to 1	Light airs and cloudy in morning; overcast with rain in afternoon.
Regina	9—09	90—22	·95	·89	+·01	...	...	Light variable winds; squalls at intervals.
rridon	9—09	91—49	·97	·91	0	E.-N.-E.	4	Thick rainy weather.
Hall	9—24	90—20	·80	·90	0	N.-W.	3	Light winds; squally.
Calcutta	9—30	83—24	·80	·91	+·02	N.-E.	4	Squally; moderate winds.
	9—46	86—26	30·04	·92	+·03	N.-E. by E.	3	Dull gloomy weather.
iranda	10—26	90—52	30·02	·88	—·02	E.-N.-E.	5	Fresh breeze; cloudy.
ni	Port	Blair	29·90	·96	+·03	E.	3	Fine and clear all day.
	15—50	86—05	29·94	·96	+·10	E.-N.-E.	4	Light showers. Fine clear weather; northerly swell.
n Abbey	16—14	87—53	30·07	·98	+·11	E. by N.	3	Fine. Gentle breeze.
	16—07	90—36	·08	·98	+·10	N.-E.	4	Squally, with heavy rain.
ry	16—24	90—05	29·90	·99	+·11	E.-N.-E.	...	Moderate breeze. Fine throughout.
oy	16—27	87—13	30·10	·97	+·11	E.-N.-E.	4	Fine. Southerly swell.
f Scots	16—30	91—00	·10	·98	+·10	E.	4	Light winds and fine. Sharp squall at 9 A.M.
han	16—40	92—40	...	...	...	E.-N.-E.	3	Moderate winds and fine.
Edmonton	17—32	86—32	...	...	...	N.-E.	...	Fine clear weather.
	16—44	83—46	29·98	29·98	+·11	N.-E.	4	Moderate breeze and fine.
	18—06	90—40	30·13	·99	+·11	N.-E.	4	Fine clear weather.
	18—45	83—43	30·05	30·00	+·12	W.	1	Light winds and clear.
	19—19	88—25	30·00	29·99	+·12	N.-N.-E.	1	Very light airs and calm.
	River Hughli		30·00	30·00	+·08	Calm.	...	Fine and clear.
. *Meteor*	Ridge Light Station, Sand-heads.		·18	·02	+·10	N.	1	Sea smooth.
. *Planet*	Intermediate Station.		·18	·01	+·09	N.	0	Sea smooth.
. *Canopus*	Mutla Station, Sand-heads.		·18	·02	+·10	Variable.	1	Variable. Very southerly swell.

These data show that the weather conditions in the Bay were very sim those of the preceding day. Thus all the ships to the north of Lat. 16° or 1 had fine weather with winds decreasing in force northwards until, at th of the Bay, they were exceedingly light. Fifteen vessels including thre vessels contribute information. All these vessels had fine weather throu the whole day, except the *Andora*, in Lat. 16° 7′ N., Long. 90° 36′ E., at which had occasional squalls and rain, and the *Queen of Scots*, 35 or 40 m the north-east, which had a sharp squall at 9 A.M., after which she experi fine weather.

To the south of Lat. 16° N. weather was, as on the 26th, slightly uns It was, however, less squally and disturbed in the western half of the cent south of the Bay than on the previous day. Some of the vessels in Lat. 1 report cloudy weather with rain, and others occasional squalls or sh Finally, in the area defined by the meridians of 88° and 93° East Long., a 6th and 12th parallels of North Lat., the meteorological conditions we same in general character as those of the previous day, but were more m than hitherto. The following table gives the available data for the determi of the weather in that area :—

VESSEL.	Hour.	Position.	Barometer corrected.	WIND.		Weather.
				Direction.	Force.	
Loch Torridon	4 A.M.	...	29·86	S.-E. to E.-S.-E.	3	Clear. Light wi 6 A.M., showery
	8	..	·93	E.	5	More settled weat
	Noon	9—9 N., 91—49 E., proceeding North at rate of 9 miles per hour.	·91	E.-N.-E.	4	Ditto.
	4 P.M.	...	·86	E.-N.-E to E.	5	Thick rainy w Squalls(force 5 t ing 10 to 20 min
	8	...	·89	E.-S.-E. to E.-N.-E.	4	Very dirty-looki Heavy-looking in south-east.
	Mid.	...	·87	E.-N-.E.	5	Wind increasin clear.
Victoria Regina	Noon	9—9 N., 90—22 E., proceeding north at rate of 7½ miles per hour.	·86	...	...	Winds light and during day fro east to south-ea heavy rain. Sq intervals; turbul sea. Very hea clouds travelli north-east to sou
	...	...	...	...	...	
Seirra Miranda	4 A.M.	...	29·77	E. by S.	6	Strong breeze fro east and squally w
	8	...	·88	E. by N.	5	
	Noon	10—26 N., 90—52E., proceeding north at rate of 10 miles per hour.	·88	E.-N.-E.	5	Fresh breeze. C
	4 P.M.	...	·82	E by N.	5	
	8	...	·89	E. by N.	5	Fresh breeze and
	Mid.	...	·88	E. by N.	5	Ditto.

VESSEL.	Hour.	Position.	Barometer corrected.	WIND.		Weather.
				Direction.	Force.	
venby Hall .	4 A.M.	...	...	N.-W.	3	
	Noon	9—24 N., 90—20 E., proceeding north at rate of 7 miles per hour.	29·90	N. W.	3	Light winds; squally.
	4 P.M.	...	·75	N.-N.-W.	4	Threatening weather; lightning and heavy rain.
	Mid-night.	...	...	...	4	

These four ships had advanced during the previous 24 honrs from Lat. 8° N. about Lat. 10° N., and had almost passed out of the region of light variable winds. he *Loch Torridon* and *Victoria Regina* were nearest to the centre of the storm, d the former, which was 90 miles further east, had variable but strongish winds d very squally weather. The *Victoria Regina* had light and variable winds om north-east to south-east (almost the same as those of *Loch Torridon*). The counts of the weather contained in these logs also serve to establish the exnsion of the disturbance. The *Loch Torridon* had a very wild-looking sky in e evening and increasing wind, with very heavy nimbus rising in the south-east d travelling to north-west. The *Victoria Regina* had heavy rain and squalls, d a turbulent cross sea, with very heavy black clouds which travelled rapidly m north-east to south-west. These changes evidently indicated the increasing verity of the rainfall and of the disturbance. Hence it is almost certain that e disturbance became one of some intensity before evening. This is confirmed the veering of the wind to north-west noticed on board the *Dovenby Hall.* e air motion in the area of disturbance during the greater part of the day had en almost as variable and irregular as on the 26th, but towards evening the nd directions indicated that a cyclonic circulation began to be established, which placed the variable irregular motion that had previously obtained. It was, wever, of comparatively small extent, for at Port Blair, the weather was fine d clear with light winds throughout, and in the south of the Bay to the west of ng. 88° E., north-east winds continued to blow with the same force and intensias hitherto.

Hence the observations of this day show that—

(1) The disturbance not only continued in the area of very slight depression to the west of the Nicobars, but increased in intensity.

(2) During the greater part of the day the air motion was irregular, but cyclonic circulation with increasing winds was established in the area of disturbance during the afternoon and evening.

The data also show that north-east to east winds prevailed over the whole of e Bay, except to the west of the Nicobars, where winds were light, irregular, d variable. Pressure was in the morning absolutely lowest in the Arabian Sea the Malabar coast. There was at the same time a tendency towards the esblishment of an area of deficient and diminishing pressure in the area of variле winds and heavy rain to the north-west of the Nicobars, and it was in this

area that the concentration of action occurred during the day which led t
development of the cyclonic disturbance and storm.

October 28th.—The following gives meteorological data for coast station

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Wea
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Mergui	29·953	—·006	+·003	N.	2	200	84·1	—4·5	66·5	—5·9	7	—	Clou
Tavoy	·941	—·011	?	N.-E.	3	?	85·2	?	67·7	?	4	—	
Rangoon	·982	—·031	+·030	N.-N.-E.	5	167	85·1	—3·6	70·3	—4·7	1	—	
Port Blair	·911	—·037	—·022	E.-N.-E.	6	100	86·0	—1·1	77·4	—1·1	4	1·20	Misty
Diamond Island	·942	—·041	—·013	E.-N.-E.	13	217	87·9	+1·4	74·5	—2·0	2	—	Fine.
Akyab	·959	—·027	+·010	S.-S.-E.	2	100	90·2	+2·2	78·6	+3·1	7	—	Fine.
Chittagong	·975	—·026	+·003	N.-N.-E.	1	33	87·6	+1·8	70·0	—1·4	2	—	
Saugor Island	·964	—·047	+·002	N.-N.-W.	7	100	87·2	+2·7	74·0	+3·1	3	0·03	Sea s
False Point	·953	—·051	—·016	N.	6	100	87·4	+1·9	68·5	—2·9	1	—	Fine.
Gopalpur	·952	—·064	—·021	N.-N.-W.	9	150	87·2	?	75·8	?	2	—	Sea s
Vizagapatam	·952	—·051	+·011	N.	0	?	87·4	+2·8	77·7	—2·1	3	—	Fine.
Cocanada	·913	—·060	?	N.-N.-E.	14	?	86·0	?	75·7	?	3	—	Sligh
Masulipatam	·918	—·059	—·018	N.-E.	8	200	91·6	+6·1	74·1	—0·9	5	—	Fine.
Nellore	·942	—·031	?	S.-E.	?	?	86·7	?	75·6	?	7	0·39	
Madras	·911	—·054	—·038	N.-N.-E.	6	120	88·0	+2·4	75·5	+1·9	8	0·52	Show
Negapatam	·895	—·030	—·016	N.-N.-W.	5	125	84·9	+0·6	74·7	+0·7	10	1·52	Sea h
Trincomalee	·874	—·046	?	E.	6	60	86·5	?	75·0	?	7	0·38	
Colombo	·872	—·052	—034	S.	3	43	87·0	?	75·0	?	10	0·41	

The barometric changes of the previous 24 hours were generally small
irregular. The barometer rose in the North Punjab and fell elsewhere. Th
was largest in Sind, Rajputana, and the Peninsula. It was large on the Ma
coast and a slight depression lay off that coast. The winds were unchang
character, except in Southern India and in West Ceylon, where they shifted
to show indraught to the Malabar coast depression, Temperature and hum
continued to decrease in Southern and Central India. Local rain showers
received in Southern India, but in much smaller amounts than hitherto, and
now confined to the eastern and southern districts.

The following gives the average district rainfall in each district of M
during the previous 24 hours :—

DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.	DISTRICT.	Average rainfall in district during previous 24 hours.	He rai di in p 24
	Inches.	Inches.		Inches.	In
Tinnevelly	2·23	3·45	Madras	0·18	
Arcot (South)	1·38	1·65	Vizagapatam	0·18	1
Trichinopoly	1·33	2·25	Kistna	0·13	
Madura	1·33	3·75	Canara (South)	0·10	
Nilgiris	0·99	0·99	Cuddapah	0·05	
Tanjore	0·85	1·52	Malabar	0·03	
Chingleput	0·75	1·15	Ganjam	0	
Coimbatore	0·51	0·91	Godavari	0	
Salem	0·43	0·80	Kurnool	0	
Nellore	0·33	0·80	Bellary	0	
Arcot (North)	0·23	0·38	Anantapur	0	

The following gives a summary of the weather information for the Bay for 28th :—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° '	° '						
utana . .	10—45	97—26	29·93	29·93	+·01	N.-E.	...	Light to moderate winds and showery.
nby Hall .	11—36	90—46	·80	·90	0	E.-N.-E.	4	Heavy squalls, with rain. Terrific squalls, with torrents of rain in evening.
ria Regina .	11—51	90—20	·92	·86	—·03	...	...	Winds variable from north-east to south, and rain-squalls.
can . .	12—08	89—05	·97	·86	—·02	E.-N.-E.	5	Dark gloomy weather.
Torridon .	12—15	91—53	·99	·93	+·03	E.-N.-E. to E.	5	Whirlwind to north at 4 P.M. Thick dirty weather; wind and squalls increasing.
a Miranda .	13—47	91—08	30·03	·89	+·01	E.-N.-E.	5	Fresh breeze and clear.
of Calcutta .	13—46	85—10	29·78	·89	+·02	N.-E.	4	Squally, with heavy rain.
wani . .	13—56	94—34	·90	·96	+·06	N.-E.	2	Fine and clear.
kha . .	15—35	82—30	·96	·91	+·03	Variable.	...	Light winds and passing clouds; evening squally.
a . . .	16—28	85—57	·99	·92	+·06	E. N.-E.	...	Fine passing clouds.
ham Abbey .	18—09	87—30	30·05	·96	+·09	E. by N.	4	Moderate winds and fine.
ra . .	18—09	91—05	·07	·97	+·09	E. by N.	3	Ditto. Sea smooth.
wa . . .	18—09	86—50	·06	·98	+·11	S.-E.	4	Fine weather; smooth sea.
n of Scots .	18—16	90—46	·10	·98	+·10	E.	...	Gentle winds. Fine pleasant weather throughout.
garry . .	18—30	90—20	29·90	·99	+·11	E.-N.-E. to E.-S.-E.	...	Unsteady winds and fine weather.
. . .	18—38	90—50	30·16	·98	+·10	E.	2	Fine and clear. Sea very smooth.
ue Edmonton .	18—37	86—55	...	...	...	E.	...	Variable breezes. Fine and clear.
e Roy . .	18—44	87—40	30·10	29·97	+·10	E.-N.-E.	4	Fine.
ra . . .	19—26	87—18	29·94	·96	+·09	E.-N.-E.	4	Fine and clear. Smooth sea.
Jehan . .	19—32	89—39	30·25	·96	+·08	N.-E.	2	Light airs and clear.
y . . .	19—59	88—24	29·96	·96	+·06	N.-E by N.	2	Nearly calm. Current so strong that ship would not answer helm.
ive . . .	20—05	87—06	·98	·98	+·09	E.-N.-E.	2	Light winds and fine.
V. Canopus .	Mutla station, Sandheads.		30·16	·99	+·07	Variable.	1	Very slight southerly swell.
V. Planet .	Intermediate station.		·14	·97	+·05	N.-N.-E.	1	Sea smooth.
V. Meteor .	Ridge Light station, Sandheads.		...	...	...	N.-E.	1	Ditto.

Although a large number of vessels contribute information of the weather ıe Bay for this day, it is not sufficient to enable the character or position of stormy weather to be accurately ascertained. The great majority of the els were in the north of the Bay, where the weather was fine and clear, with : to moderate north-east winds and a smooth sea. The vessels which passed he 26th and 27th through the area of variable winds to the west of the ›bar Islands had now advanced north to the west of the Andamans. Their indicate that the weather was becoming more unsettled and squally, and the area of disturbed weather was extending northwards. Light east-north-winds continued at Port Blair, but the weather was changing and becoming ttled and threatening, skies were now overcast, and occasional showers : falling.

The following gives the whole of the meteorological information of the contained in the logs of the five vessels, the *Dovenby Hall, Victoria Regina, Torridon, Sierra Miranda* and *Arracan :—*

VESSEL.	Hour.	POSITION AT NOON.		BAROMETER.		WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Direction.	Force.	
		° ′	° ′					
Dovenby Hall . .	4 A.M.	...	...	...	...	N.-E. by N.	3	Cyclonic appearanc
	8 "	...	...	29·73	29·83	E.-N.-E.	4	
	Noon	11—35	90—46	·80	·90	...	...	
	4 P.M.	...	...	·65	·95	N. by E.	3	Heavy squalls with
	8 "	...	...	...	...	...	4	
	Mid.	...	...	...	...	N.-N.-E.	11	Terrific squalls wit rents of rain.
Victoria Regina . .	Noon	11—51	90—20	·92	·86	N.-E. to S.-E.	...	Light variable wind heavy rain-squalls tervals and a con sea.
Loch Torridon . .	4 A.M.	...	...	·90	·84	E.-N.-E.	6	Strong monsoon.
	8 "	...	...	·97	·91	...	5	Fresh ditto.
	Noon	12—15	91—53	·99	·93	E.-N.-E. to E.	5	Threatening to S.-E
	4 P.M.	...	...	·93	·87	E. to E. S.-E.	4	Whirlwind to N.
	8 "	...	...	·99	·93	N.-E. to S.-E.	6	Thick, dirty weathe
	Mid.	...	...	·98	·92	E.	4	Squalls increasing.
Sierra Miranda . .	4 A.M.	...	...	·96	·82	E. by N.	5	Fresh breeze and cl
	8 "	...	...	30·02	·88	E.-N.-E.	5	Ditto.
	Noon	13—47	91—08	·03	·89	E. by N.	5	Fresh wind and wea slight swell.
	4 P.M.	...	...	29·97	·83	E.-N.-E.	5	Fresh breeze, clear.
	8 "	...	...	30·05	·91	E. by N.	5	Ditto.
	Mid.	...	...	·05	·91	...	...	Dttto.
Arracan . . .	4 A.M.	...	...	29·91	·80	E.-N.-E.	4	Clear weather.
	8 "	...	...	·98	·87	E.-N.-E.	4 to 5	Ditto.
	Noon	12—08	89—05	·97	·86	E.-N.-E.	5	Ditto.
	4 P.M.	...	...	·93	·82	E. by N.	5	Cloudy, gloomy, S.- S.-W.
	8 "	...	...	·99	·88	E. by S.	...	Dull gloomy wea passing showers.
	Mid.	...	...	·98	·87	S.-E. by E.	...	Ditto.

October 29th.—The following table gives the 8 A.M., observations at the co stations of the Bay of Bengal for the 29th :—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weathe
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Mergui . .	29·951	—·002	+·011	N.-N.-E.	2	200	87·2	—0·6	67·0	—5·4	8	—	Cloudy.
Tavoy . .	·943	+·002	?	N.-N.W.	3	?	87·2	?	68·2	?	2	—	
Rangoon . .	·997	+·015	+·041	N.-E.	5	166	85·6	—2·0	72·4	—2·8	0	—	
Port Blair .	·937	+·026	+·007	S.-S.-E.	15	250	88·5	+1·4	77·4	—1·3	4	—	Misty.
Diamond Island	·962	+·020	—·017	E.-N.-E.	14	233	84·4	—2·7	73·0	—3·3	2	—	Fine.

TATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
b . .	·995	+·036	+·035	E.	2	100	89·2	+0·3	76·6	+1·1	8	—	
agong .	30·017	+·042	+·036	N.-N.-E.	1	33	87·6	+1·5	71·0	+0·9	0	—	
or Island .	29·997	+·033	+·032	N.-E.	6	86	86·7	+2·1	72·5	+0·7	3	—	Sea smooth.
Point .	·989	+·036	+·004	N.-N.-W.	7	117	86·9	+1·9	75·6	+4·5	2	—	Fine.
lpur .	·988	+·036	—·011	N.-N.-W.	10	17	86·2	?	75·8	?	1	—	Sea smooth.
apatam .	·955	+·003	+·008	N.	1	50	86·9	+2·6	80·1	+1·0	4	—	Fine.
iada .	921	+·008	?	N.-N.-E.	15	?	85·5	?	75·6	?	1	—	Slight.
lipatam .	·916	—·002	—·010	N.-N.-E.	9	225	92·1	+6·6	74·1	+1·0	6	—	
re . .	·899	—·043	?	N.-W.	?	?	89·7	?	75·0	?	10	0·11	
as . .	·907	—·004	—·026	N.-N.-E.	6	120	88·0	+4·1	74·5	+0·9	4	0·02	Fine.
patam .	·879	—·016	—·020	N.-W.	3	75	81·9	—1·4	72·7	—1·6	7	0·88	Sea rough.
omalee .	·884	+·010	?	Calm.	4	40	89·5	?	76·0	?	7	0·03	
nbo .	·902	+·030	—·038	S.-S.-E.	6	86	84·0	?	74·0	?	10	1·35	

During the previous 24 hours the barometer continued to fall in the Penin- . Pressure increased in all other districts. The rise in Northern and Cen- India and in Upper India was large in amount, varying from a fifth to a ı of an inch in the Punjab. By these changes, unusually high pressure was blished over Northern India and steep gradients prevailed in North-Western Western India, the difference between the Punjab and Malabar being nearly rd of an inch. Winds were still light and unsteady in Northern India. erate northerly winds prevailed in Bengal and easterly winds on the Burma t. A remarkable feature of the weather at this time was the strong east- winds which prevailed in the Bombay coast districts as well as in Burma. normal direction of the wind in October in both areas is almost due north. unusual easting of the winds at the Bombay coast stations was probably to the unsettled weather over the Arabian Sea at this time (the evidence hich is given below), and to the slight depression in existence off the Malabar , as shown by the barometric and wind observations at the Malabar coast . Local showers had fallen during the preceding 24 hours in the Punjab, orth-Western Provinces, Central Provinces, Central India, Rajputana, and ıdeish, but the amounts were generally small. The largest was a fall of 1½ s at Indore (during a hail-storm). One inch was received at Simla during al hail-storm. Some rain also fell in Southern India, but the amounts were er than hitherto.

The following table gives the average and largest fall during the previous ours in each district in the Madras Presidency, and shows that the rainfall ıow comparatively small in amount in that area:—

DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.
	Inches.	Inches.
Tinnevelly . .	1·36	2·90
Nellore . .	0·69	2·40
Madura . .	0·47	1·60
Nilgiris . .	0·37	0·37
Arcot, South . .	0·33	0·80

DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.
	Inches.	Inches.
Malabar	0·33	1·00
Madras	0·31	0·31
Tanjore	0·30	0·88
Chingleput	0·23	0·50
Arcot, North	0·15	0·25
Vizagapatam	0·08	0·50
Coimbatore	0·07	0·13
Trichinopoly	0·04	0·04
Salem	0·03	0·12
Kistna	0·02	0·02
Ganjam	0	0
Godavari	0	0
Kurnool	0	0
Cuddapah	0	0
Canara South	0	0
Bellary	0	0
Anantapur	0	0

The noon observations in the Bay of Bengal for the day are given in the following table:—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Medea	7—13	82—02	29·96	29·91	—·01	S.-E.	2	Cloudy.
Ethiopia	Madras		...	...	...	...	...	Fine and clear; sea smooth day. Evening—hard s sea rising.
Goorkha	Do.		·96	·91	+·02	N.-E.	3	Fine weather. Evening breeze and rain-squalls.
Arracan	13—57	91—59	30·04	·93	+·04	E.	5	Squalls, with heavy rain.
Dovenby Hall	14—27	91—07	29·70	·92	+·04	E.	10	Sweeping squalls. Heav
Peshwa	14—37	85—16	30·00	·92	+·05	E.-S.-E.	4	Squalls increasing in for heavy rain and high sea.
Victoria Regina	14—39	90—23	29·95	·89	+·01	...	...	Very violent squalls an heavy rain.
Rajputana	14—42	96—42	·97	·97	+·06	E.-N.-E.	...	Light breeze and fine.
Loch Torridon	15—20	91—50	·99	·93	+·04	E.-N.-E.	6	Strong wind and fine wea
Maharani	Rangoon		·94	30·00	...	N.-E.	1	Fine and clear.
Sierra Miranda	17—35	90—55	30·06	29·92	+·04	N.-E. by E.	5	Fresh breeze. Fine cle ther.
City of Calcutta	18—04	86—51	29·80	·94	+·07	N.-E.	5	Fresh breeze and clear.
Mount Tabor	18—57	87—50	30·17	·95	+·08	E.	4	Overcast. Increasing wind
Castle Roy	19—23	87—30	·12	·99	+·12	E.-N.-E.	4	Squally at sunrise; fine day.
Barque Edmonton	19—29	87—11	...	...	...	Variable	...	Weather fine and clear.
Foyle	19—30	90—22	·14	30·00	+·10	N.-E.	4	Fine and clear.
Evesham Abbey	19—33	87—40	...	·00	+·12	E.-N.-E.	3	Light breeze and fine.
Andora	19—53	90—07	·06	29·96	+·08	N.-E.	4	Fine; slight southerly sw
Queen of Scots	20—11	89—30	...	...	...	E.-N.-E.	4	Light breeze; fine pleasant
Kistna	20—15	87—48	·06	·99	+·11	N.-N.-E.	3	Fine and clear.
Khedive	Saugor Roads		·00	30·00	+·08	E.-N.-E.	1	Light airs and fine.
Shah Jehan	Hughli River		·32	·03	+·11	N.	1	Light airs and calms.
F. L. V. Canopus	Mutla station, Sandheads.		·16	·00	+·08	N.-N.-E.	2	Very slight southerly sw
F. L. V. Planet	Intermediate station, Sandheads		·18	·01	+·09	N.-N.-E.	2	Sea smooth.
F. L. V. Meteor	Ridge Light station, Sandheads.		·17	·00	+·08	N.-E.	1	Ditto.

ıe position and extent of the cyclonic storm are only vaguely shown by ›bservations. The ships passing up the east of the Bay had advanced as Lat. 14° to 16° N., and although they were not beyond the influence of the ing cyclonic storm, their observations do not permit the centre to be as-ed with exactness. So far as can be judged, the centre was probably in Lat. 11½° N. and Long. 88° E. The squally weather accompanying the ance was rapidly extending northwards and eastwards, and the frequency verity of the squalls increasing. The *Sierra Miranda, Loch Torridon, ia Regina, Arracan,* and *Dovenby Hall* had advanced steadily northwards verage rate of ·8 miles per hour during the previous 24 hours, but were ithin the area of increasing and extending disturbance. They were at es of from 200 to 300 miles to the north-east.

ıe following gives the whole of the observations taken on board these during the day :—

SSEL.	Hour.	POSITION AT NOON.		BAROMETER.		WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Direction.	Force.	
		° ′	° ′					
Regina .	Noon.	14—39	90—23	29·95	29·89	E.		Very violent squalls and very heavy rain; strong easterly winds and squally with heavy rain in the afternoon.
ridon .	4 A.M.	...	...	29·93	29·87	E.	9	Squalls.
	8 A.M.	...	...	·99	·93	E.-N.-E.	6	Strong monsoon.
	Noon.	15—20	91—50	·99	·93	E.-N.-E.	6	Wind strong and steady.
	4 P.M.	...	...	·95	·89	E.-N.-E.	5	Wind less and fine.
	8 P.M.	...	...	30·03	·97	E.-N.-E.	4	Wind less and clear.
	Mid.	...	...	·03	·97	E.-N.-E-	4	
Hall .	4 A.M.	...	...	29·65	·87	E.-S.-E.	8	
	8 A.M.	...	...	·65	·87	E. by S.	9	Thunder and lightning; every appearance of cyclone.
	Noon.	14—27	91—7	·70	·92	E.	10	Sweeping squalls.
	4 P.M.	...	...	·55	·77	E.-S.-E.	11	
	8 P.M.	...	...	...	...	S.-E.	10	Blowing hard in gusts, and squalls, with heavy rain.
	Mid.	...	...	...	...	S.-W.	9	
. .	4 A.M.	...	...	29·96	·85	S.-E.	4	Squalls, with heavy rain; force of wind in squalls 5 to 6.
	8 A.M.	...	...	30·03	·92	E. by S.	5	Dull gloomy weather; passing showers.
	Noon.	13—51	91—59	·04	·93	E.	5	Rain squalls.
	4 P.M.	...	...	29·98	·87	E. by N.	4	Cloudy.
	8 P.M.	...	...	30·06	·95	E.-S.-E.	4	Clear weather.
	Mid.	...	...	·07	·96	E.	3	Ditto.
Miranda .	4 A.M.	...	...	30·01	·87	N.-N.-E.	5	Fresh breeze.
	8 A.M.	,,	...	·09	·95	N.-E. by E.	5	Ditto.
	Noon.	17—35	90—55	·06	·92	N.-E. by E.	5	Ditto.
	4 P.M.	...	...	·02	·88	N.-E. by E.	5	Ditto.
	8 P.M.	...	...	·08	·94	N.-E.	5	Ditto.
	Mid.	...	...	·09	·95	N.-E.	5	Light breeze and fine.

The *Dovenby Hall*, in Lat. 14° 27′N. and Long. 91°7′E. at noon, had stormy cyclonic weather during the day, sweeping squalls with heavy rain ing over the vessel. The force of the wind in the squalls was estimated a This appears to be an exaggerated estimate, as the *Arracan*, which was about 60 miles to the east at noon, and also advancing in a northerly dire at approximately the same rate, also had frequent squalls with very heavy The captain of the *Arracan* states that the force of the wind in the squall 5 to 6. These observations, however, indicate plainly the extension of the s area, and the increasing severity of the weather in the storm area during the The *Loch Torridon* advanced northwards beyond the storm area in the aften She experienced strong easterly winds in the morning (force 6 to 9) with cl skies. The weather cleared up in the afternoon and at midnight was fine clear.

The *Peshwa*, 300 miles to the north-west of the centre (and procee south-south-west), had squally weather with increasing winds throughout the They were, however, from east-south-east to north-east, so that, if correct, show that the winds were cyclonic in direction at distances of 200 to 300 n to the west of the storm.

Weather was fine on the Coromandel coast districts during the whole of day, but in the evening skies began to cloud over at Madras, and occasi squalls passed over that town. The wind also shifted during the night f north-east (its normal direction) to north-north-west.

Over the whole of the west and north-west of the Bay weather was fine clear, with light to moderate north-east winds, and a smooth sea.

October 30th.—The following are 8 A.M. observations at stations on the c of the Bay and in Southern India:—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weath
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Mergui	29·929	−·022	−·007	N.-N.-E.	2	200	89·6	+2·9	69·5	−2·8	3	...	Cloudy.
Tavoy	·936	−·007	?	Calm.	3	?	90·2	?	74·2	?	8	...	
Rangoon	·981	−·016	+·034	E.-N.-E.	4	133	88·0	+0·2	74·9	−0·8	7	...	Fine.
Port Blair	·918	−·019	−·008	S.-E.	10	167	88·5	+1·4	78·4	+0·8	4	2·60	Misty.
Diamond Island	·964	+·002	+·009	E.	11	183	85·4	−1·7	74·5	−2·2	4	...	Fine.
Akyab	·982	−·013	+·046	N.-E.	3	150	89·7	+0·7	77·1	+1·8	7	...	Fine.
Chittagong	30·007	−·017	+·053	N.	1	33	88·1	+1·9	71·0	+0·8	2	...	Fine.
Saugor Island	·016	+·019	+·057	N.	8	114	87·7	+3·3	72·5	+1·7	7	...	
False Point	29·992	+·003	+·032	N.	7	117	86·9	+2·5	72·6	+1·2	7	...	Wind va able.
Gopalpur	·990	+·002	+·026	N.-N.-W.	15	250	87·2	?	77·3	?	3	...	Sea slight
Vizagapatam	·965	+·010	+·038	N.-E.	4	200	86·4	+2·7	78·2	−1·3	10	...	
Cocanada	·877	−·044	?	N.-E.	22	?	87·5	?	77·6	?	10	...	Rough.
Masulipatam	·897	−·019	−·008	N.	9	225	93·1	+9·5	76·5	+3·2	10	...	
Nellore	·906	+·007	?	N.-W.	?	?	84·2	?	74·6	?	10	1·36	
Madras	·893	−·014	+·003	N.-W.	8	160	88·5	+5·0	74·0	+0·5	10	2·84	
Negapatam	·891	+·012	−·004	N.-W.	4	100	85·4	+1·1	76·7	+2·7	8	0·16	Sea rough,
Trincomalee	·870	−·014	?	W.	6	60	91·0	?	74·5	?	5	0·09	
Colombo	·934	+·032	+·005	W.-N.-W.	10	143	83·5	?	76·0	?	10	0·10	

The barometer had risen over the whole of Central and Northern India, and ish gradients, favouring north-east winds, were now established over the north e Bay and in the Arabian Sea. It had also risen briskly over the Malabar , and the shallow depression which had been a feature of the weather of the ous three or four days disappeared. The weather, which had been slightly tled and squally on that coast for some days previous, now improved. The neter was beginning to fall on the Coromandel coast, but the changes were t very small. North-west winds had set in during the previous night and increasing rapidly in strength. Heavy rain was also falling in the Coromandel coast districts south of Nellore and the sea was rising. The storm centre M. was probably about 350 miles to the east by south of Madras.

The following table gives the average rainfall and heaviest rainfall in each ct of the Madras Presidency during the previous 24 hours :— .

DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.	DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.
	4·72	4·72	Cuddapah	0·05	0·10
put	1·73	2·50	Godavari	0·05	0·15
	1·06	2·95	Coimbatore	0·04	0·12
patam	0·70	2·90	Tanjore	0·03	0·16
r	0·59	1·99	Trichinopoly	...	..
	0·32	1·10	Salem	...	...
	0·29	0·29	Canara (south)	...	...
north)	0·25	2·45	Ganjam	...	...
elly	0·13	0 40	Kurnool	...	...
south)	0·10	0·20	Bellary	...	...
	0·07	0·20	Anantpur	...	...

he 4 P.M. observations at the coast stations given below show no large or tant change of the weather.

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P. M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
	29·812	—·014	—·009	N.	2	200	7	
n	·865	—·011	+·020	E.-N.-E.	4	133	2	
ir	·842	+·007	+·024	E.-S.-E.	8	133	3	Misty.
d Island	·865	+·002	+·008	E.	9	150	4	
	·870	—·051	+·021	W.-N.-W.	3	150	1	
ng	·886	—·004	+ 031	W.	1	33	5	
Island	·899	+·003	+·046	N.-E.	6	86	9	Misty.
oint	·897	—·012	+·027	N.-E.	8	133	10	Gloomy.
r	·928	+·019	+·059	N.	15	250	10	Drizzling.
atam	·867	+·002	+·037	N.-E.	4	200	10	
atam	·780	—·045	—·030	N.-E.	10	250	10	
	·774	—·040	—·023	?	12	240	10	
am	·787	—·020	—·005	N.-W.	5	125	8	

The following table gives a summary of the noon observations taken board vessels in the Bay on this day :—

Vessel.	Position at Noon.		Barometer.			Wind.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Kohinoor	6 22	81 44	29·90	29·85	—·03	W.	...	Moderate wind and sea. weather after noon.
Medea	10 09	81 54	·90	·90	—·05	N.-W.	6	Heavy rain.
Peshwa	11 57	83 57	·90	·82	—·06	S.-W.	7	
Bhandara	Madras		·69	...	...	W.-N.-W.	...	Light, constant rain.
Clive	Madras		·90	·87	—·03	N.	2 to 3	Weather threatening, with squalls and much rain thro out.
Goorkha	Madras		·86	·81	—·09	N.-N.-W.	4	Heavy rain; light to mod breeze. Strong breeze heavy squalls, and rain i afternoon.
Ethiopia	15 14	81 20	·74	·83	—·05	N.	8	Hard squalls; rain; sea r Wind increasing to fresh g
Arracan	15 15	95 08	30·07	·96	+·06	E.-N.-E.	3	Clear.
Dovenby Hall	15 49	91 21	...	...	...	S.-E.	7	Cyclonic appearance. T squalls and high confuse in the afternoon.
Sirsa	Masulipatam		29·84	29·92	·04	N. & E.	...	Strong breeze; high confuse with heavy squalls.
Mount Tabor	16 05	85 58	30·17	·95	+·09	E.	6	Sky looking ugly. Heavy squally.
Victoria Regina	16 53	90 59	·03	·97	+·09	[illegible]	...	Light and moderate breeze east-north-east
Loch Torridon	18 07	91 44	·05	·99	+·11	N.-N.-E.	3	Steady light wind and fine, erly swell.
Foyle	19 30	91 00	·13	·99	+·11	N.-E.	3	Cloudy weather.
Barque Edmonton	19 41	87 40	...	...	...	...	...	Easterly variable breezes.
Andora	19 50	91 18	·10	30·00	+·11	N.-E. by E.	3	No perceptible current.
Sierra Miranda	19 52	89 52	·11	29·97	+·09	N.-E.	5	Light breeze and cloudy.
Castle Roy	19 54	87 51	·10	·97	+·09	E.-N.-E.	3	Overcast.
Gilroy	20 27	87 56	29·99	·98	+·10	N.-E. by E.	2	Light breeze; passing clou
Akbar	20 45	87 57	·92	·99	+·10	N.-W.	2	Light breeze and clear.
F. L. V. Planet	Intermediate station.		39·20	30·03	+·11	N.-N.-E.	2	Sea smooth.
F. L. V. Meteor	Ridge Light station, Sand-heads.		·18	·03	+·11	N.-N.-E.	1	Ditto.
F. L. V. Canopus	Mutla station, Sandheads		·20	·03	·11	N. E.	3	Very slight south-easterly

These observations show clearly the extension of the disturbance in the Skies were now overcast over the whole of the Bay to the south of Lat. and were more or less clouded in Bengal and at the head of the Bay. T north of Lat. 16° N., north-east winds prevailed and decreased in force wards from 6 in Lat. 16°N. to 2 at the head of the Bay. Weather was s over the Bay to the south of Lat. 16° N. The area of depression (as defi the isobar of 29·85) was oval-shaped, the longest diameter running approxi east and west. The centre of the depression and circulation was prob

12° N. and Long. 85½° E. at noon. The following gives the distance and
ing of the centre from several vessels at that time :—

VESSEL.	Distance and Bearing of centre.	WIND. Direction.	WIND. Force.	Bearing angle.	Weather.
. . . . .	250 miles N.-E. to E. .	N.-W.	6	102°	Heavy rain.
z	125 „ N.-E. . .	S.-W.	7	...	
ʼa	350 „ S.-E. . .	N.	8	130°	Fresh gale.
a	350 „ E.-S.-E. . .	N.N.-W.	3	145°	Fresh breeze.
y Hall . . .	450 „ W.-S.-W. . .	S.-E.	7	105°	Terrific squalls.
Tabor . . .	300 „ S. by W. . .	E.	6	98°	Squalls.

The *Dovenby Hall*, although upwards of 450 miles distant from the centre,
errific easterly squalls in the afternoon, with a high confused sea. The *Mount*
r, 300 miles to north of the centre at noon, experienced frequent squalls
heavy rain and a high confused sea throughout the day. At 8 P.M. the
rly winds increased for some time to force 8. The sea came up chiefly from
-south-east to south, and was hence due to the distant cyclonic storm.
bank of clouds of the storm area was observed in the afternoon on board
Foyle when she was in about Lat. 20° N. The log of the *Sierra Miranda*
e same latitude notes the very dark red colour of the sky at sunset, and all
els in the north of the Bay viewed the occurrence of distant lightning to the
n during the night. The *Peshwa* passed through the western quadrant of
torm area on this day, but the information contained in her log throws no
on the position or character of the storm at this time.

October 31st.—The following table gives 8 A.M. observations at the Bay
engal coast stations and in Southern India :—

TION.	BAROMETER. Actual, reduced to sea-level.	BAROMETER. Change since 8 A.M. previous day.	BAROMETER. Variation from normal.	WIND. Direction.	WIND. Velocity per hour.	WIND. Percentage ratio of actual to normal velocity.	TEMPERATURE DURING PREVIOUS 24 HOURS. Maximum.	TEMPERATURE DURING PREVIOUS 24 HOURS. Variation from normal.	TEMPERATURE DURING PREVIOUS 24 HOURS. Minimum.	TEMPERATURE DURING PREVIOUS 24 HOURS. Variation from normal.	Cloud proportion.	Rainfall in past 24 hours.	Weather.
lair .	29·956	+·038	+·027	E.-S.-E.	3	50	86·5	—0·6	74·9	—2·8	10	1·20	Thunder and lightning.
nd Island	·953	—·011	0	N.-E.	5	83	86·4	+0·1	76·0	—1·1	2	—	Distant lightning.
r Island .	·976	—·040	+·018	N.-E.	5	71	87·7	+3·9	75·5	+3·6	9	—	Sea smooth.
Point .	·959	—·033	+·024	N.	9	150	86·9	+3·2	74·6	+1·4	10	—	
our .	·972	—·018	+·038	N.-N.-W.	12	200	85·2	?	74·8	?	10	1·17	Sea rough.
patam .	·922	—·043	+·038	N.-E.	2	100	84·4	+1·6	75·7	—3·8	10	3·70	
ada .	·850	—·027	?	N.-E.	28	?	85·5	?	73·6	?	10	1·19	Rough.
lerabad .	·923	—·063	—·033	N.-N.-E.	5	125	86·6	+2·9	70·4	+5·2	5	—	
ur .	·946	—·039	+·018	E.	17	243	93·7	+5·6	68·0	+3·5	10	—	
m. .	·907	—·045	+·016	E.-S.-E.	12	120	86·2	+4·2	63·9	+0·6	4	—	Fine.
' . .	·916	—·060	+·002	N.	5	125	88·4	+1·5	71·8	+1·9	7	—	
pah .	·870	—·070	?	?	?	?	90·0	?	74·3	?	10	0·09	
ol . .	·895	—·082	?	?	?	?	92·0	?	71·9	?	4	—	

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Masulipatam	29·865	—·032	—·040	N.	9	225	87·0	+2·7	71·1	—2·4	8	0·25	Drizzling.
Bangalore	·913	—·052	—·032	N.-W.	4	100	78·0	—0·9	66·5	+2·0	6	—	Fine.
Mercara	26·169	—·030	?	N.	5	125	79·3	+3·8	63·7	+1·7	8	—	
Wellington	24 219	—·040	—·007	N.-N.-W.	3	100	71·0	+2·9	57·0	+1·8	8	—	Threatening.
Madras	29·735	—·158	—·165	N.-W.	14	280	76·0	—8·3	73·0	—1·4	10	4·40	Ditto.
Salem	·910	— 042	—·014	W.	1	33	89·5	+1·8	69·0	—0·2	9	0·01	Fine.
Coimbatore	·894	—·062	—·008	S.-S.-E.	1	33	86·8	+0·5	?	?	7	—	Fine.
Negapatam	·808	—·083	—·073	W.	5	125	82·9	—1·4	77·7	+2·9	10	—	

The barometer fell during the previous 24 hours over the whole of Northern and Central India, but the changes were generally small and unimportant. It was falling rapidly on the Coromandel coast at Madras, and briskly over the greater part of the Peninsula. The fall was greatest at Madras (·16″), Kurnool (·08″), and Cuddapah (·07″), or in the direction of advance of the storm.

Light westerly winds prevailed in Upper India, where the weather was fine and skies clear. Skies were clouded in Bengal and the greater part of the Peninsula, and heavy rain was now falling in the coast districts from Madras to Gopalpur. The barometer was rising at Port Blair, and very light east-south-east winds were blowing at that station. The storm centre was about 150 miles to the east by south of Madras at 8 A.M. Very strong winds approaching in force to a gale were already blowing at Madras, Nellore, Cocanada, and Masulipatam, and strong winds were blowing across the Deccan, in the northern and north-western outskirts of the storm, more especially at Sholapur. On the other hand, the winds in the south-west quadrant, as shown by the Salem, Coimbatore, and Negapatam observations, were as yet extremely light.

The following table gives the average rainfall and heaviest rainfall in each district of the Madras presidency during the previous 24 hours :—

DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.	DISTRICT.	Average rainfall in district during previous 24 hours.	Heaviest rainfall in district in previous 24 hours.
Madras	9·20	9·20	Cuddapah	0·05	0·10
Arcot (north)	2·45	6·05	Tanjore	0·02	0·10
Chingleput	2·42	4·90	Tinnevelly	...	...
Nellore	1·49	3·70	Arcot (south)	...	...
Godavari	1·42	1·85	Trichinopoly	...	...
Ganjam	0·64	1·17	Madura	...	...
Salem	0·29	2·60	Nilgiris	...	...
Vizagapatam	0·46	1·70	Coimbatore	...	...
Kistna	0·40	0·95	Canara (south)	...	...
Kurnool	0·32	0·95	Bellary	...	...
Malabar	0·24	1·25		...	...
Anantpur	0·13	0·25		...	...

ıe 4 P.M. observations at selected stations are given below :—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P. M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
ir	29·869	+·026	+·033	S.-E.	11	183	8	Misty.
l Island	·851	—·014	+·015	E.-S.-E.	15	250	4	
sland	·877	—·023	+·022	N.-E.	7	100	10	Misty.
›int	·883	—·014	+·027	E.-N.-E.	9	150	10	
r	·885	—·043	+·044	N.-N.-W.	9	150	10	
atam	·868	+·001	+·057	N.-E.	1	50	10	
rabad	·794	—·027	0	E.-N.-E.	16	400	9	
r	·787	—·007	+·013	N.	21	300	8	Strong wind.
ı	·761	—·010	—·006	E.-N.-E.	16	160	8	
	·735	—·051	—·022	N.	10	250	8	
ah	·778	—.015	?	?	?	?	10	
	·753	—·030	?	?	?	?	9	
atam	·773	—·007	—·024	N.-E.	13	325	10	
re	·761	—·056	—·018	N.-W.	6	150	8	
	26·095	—·052	?	N.-W.	5	125	9	
ton	24·155	—·032	—·008	N.-N.-E.	9	300	10	
	29·486	—·287	—·277	N.-W.	22	440	10	Thunder and lightning.
	·771	—·058	+·025	W.	2	67	8	
tore	·767	—·051	—·011	S.	6	200	7	

These observations show little change except at Madras, where the baro-
: was steadily and rapidly falling, and was now nearly three-tenths (·28″)
r the normal of the day and hour. At Sholapur, Belgaum, Cuddapah, and
ool, the barometer was practically steady, and stood at the same height as at
. of the previous day, and hence afforded no indication of the approaching
ı. The air motion was rapidly increasing on the Coromandel coast and in
eninsula. At Madras, Masulipatam, Sholapur, and Secunderabad, the winds
from three to five times their normal force. The cyclonic circulation now
led nearly the whole of the Peninsula as well as the Bay. The storm area
comparatively small feature in this large area, probably not more than 300
o miles in its greatest diameter. The centre at noon was in Lat. 12¾° N.
ong. 82° E., and at 4 P. M. was about 65 miles east by south from Madras.

The noon observations of the 31st extracted from the logs of ships in the B of Bengal on this day are few in number. They are given below :—

VESSEL.	POSITION.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Peshwa . . .	8—51	82—59	29·97	29·89	—·01	S.-S.-W.	4	Clear weather.
Goorkha . . .	50 to 80 miles south of Madras.		·71	·66		N.-W. by W.	5	Continual rain.
Medea . . .	12—32	80—20	·82	·77	—·12	N.-W. by W.	4	Heavy rain.
Mount Tabor . .	14—28	84—53	...	...	...	E.-S.-E.	7	Squalls, with torrents of rain lightning; nasty cross and c fused sea.
Dovenby Hall .	17—55	90—45	30·00	29·90	+·02	E.-S.-E.	5	Vivid lightning.
Victoria Regina .	18—34	90—18	·00	·94	+·06	...	...	Light breeze. Fine weather.
Loch Torridon .	19—14	90—40	·03	·97	+·09	N.-N.-E.	3	South-westerly swell.
Castle Roy . .	19—57	88—37	·12	·99	+·11	E.-N.-E.	4	Water spout to north-west. Overcast.
Barque Edmonton .	19—59	87·52	...	...	...	...	...	Easterly variable breezes.
Foyle . . .	20—01	90—30	·13	·99	+·09	N.-E.	5	Cloudy weather.
F. L. V. Planet .	Intermediate station.		·16	·99	+·07	N.-E.	2	Sea smooth.
F. L. V. Canopus .	Mutlah station.		·15	·99	+·07	N.-E. by N.	3	Light south-west swell.
Sierra Miranda .	Near Mutlah.		·08	·97	+·05	N.-N.-E.	5	Southerly swell.
F. L. V. Meteor .	Ridge Light station, Sandheads.		·15	30·00	+·08	N.-N.-E.	3	Ditto.

The majority of the vessels were near the head of the Bay. The weat was fine and cloudy to the north of Lat. 18° N., with light to moderate north- breezes.

There were several vessels at anchor in Madras harbour on the mornin the 31st. The warning signal was hoisted at 11-30 A.M. of the 30th, and the d ger signal at 11 P.M. of the same day. These vessels accordingly left the har shortly afterwards and proceeded to sea. They all encountered the storm, in one case at least suffered severely. The account of the weather as experien by these vessels is given below. At Madras, hard squalls with continuous he rain came down at frequent intervals, and the wind increased until it b with almost hurricane force in the evening. The *Mount Tabor*, about 250 m to the east-north-east of the centre, in the morning had heavy squalls with torrents of rain. The *Medea* and *Goorkha*, each probably about 80 to 100 miles south-south-west of the centre, had continual rain with north-west by west winds of force 4 to 5. The *Peshwa*, further south in Lat. 9° N., had fine clear weather.

We have fairly complete accounts of the progress of the storm in the Bay of Bengal during the afternoon and evening of the 31st.

The I. G. S. *Clive* passed through the centre of the storm at 6 P.M. She was lying at anchor at Madras on the morning of the 30th. The weather became threatening in the afternoon, with frequent hard squalls and heavy rain. The squalls became more severe on the morning of the 31st, at which time masses of cumulus scud from north-west were flying past at low altitudes. At 0-50 P.M. the vessel weighed anchor and proceeded at full speed to the south-east. At 2-30 P.M. it was blowing a whole gale from west-north-west with violent squalls, incessant blinding rain, and a confused north-east sea. She was apparently carried rapidly towards the centre by the north-easterly currents in the southern quadrant, and at 5-45 P.M., when it was blowing a fresh cyclone, she hove-to. At 5-55 P. M. the calm area passed over the vessel, and there was a lull for ten minutes, after which the wind came down from south-west by west, and blew for some time with hurricane violence. It began to moderate at 8-35 P.M., but hard squalls continued to pass over the vessel during the remainder of the night. At 5 A.M. of the 1st there was a dense bank of cumulus cloud over the west horizon 20° in altitude, and at 5-30 A.M. the weather began to break in the south-east quarter and sky to clear. The vessel was probably about 45 miles to the east-south-east of Madras when the storm centre passed over her. A very careful series of barometric readings were taken on board the *Clive*. They are charted in Plate XXXIV, and are also given in Appendix B, to which the reader is referred. The lowest reading of the barometer (corrected) in the calm centre was 29·19″ at 6 P. M.

The next vessel in order of time which passed through the inner storm area was the *Sirsa*. She left Masulipatam for Madras at 8-45 A.M. of the 30th. She experienced a strong breeze with high cross sea at 6 P.M., when she reduced speed but continued on the same course. The weather was then very squally. At 2 A.M. it was blowing a heavy gale with frequent squalls and heavy rain and high sea. At 2-30 A.M. she hove-to and rounded her head to seaward. The weather became rapidly worse. At 8 A.M. it was blowing a terrific gale with hard squalls, heavy rain, and increasing sea. The vessel, when she hove-to, was probably about 50 miles to the north-west of the storm. She drifted during the afternoon towards the centre, and was probably not more than 5 miles from the calm area at 7 P.M., at which time the barometer had fallen to 28·82. She continued to experience a terrific gale and hurricane winds until midnight. The barometer stood at 28·86″ at 11 P.M., but began to rise rapidly after that hour. The weather commenced to moderate at 2 A.M. In consequence of the vessel steering from Masulipatam into the dangerous quadrant of the storm (the north-westerly or right advancing quadrant), she drifted under the force of the strong currents close to the edge of the calm central area, and was then probably carried with the storm for about four hours from 7 P.M. to 11 P.M., during which the barometer rose only from 28·82″ to 28·86″. Her observations are charted in Plate XXXIV, and are also given in Appendix B. The comparison of her barometer curve with that of Madras is interesting.

The B. I. S. *Bhandarà* encountered the full weight of the storm about the same time as the *Sirsa*. She was lying in Madras harbour on the 30th, and had about 600 coolies on board. Her log notes that a strong southerly current (evidently due to the approaching storm) was running on the morning of the 31st. The weather became rapidly worse during the day, and at 4 P.M. was blowing a heavy westerly gale. She remained at anchor until nearly 6 P.M., when the storm centre was only about 40 miles off, and then proceeded to sea in an east-north-easterly course. The barometer was falling rapidly, thus indicating that she was entering the inner storm area. At 8 P.M. it was blowing a hard gale with heavy frequent squalls and a high confused sea. The ship would not answer her helm, and was quite unmanageable. At 9-50 P.M., when the barometer was 29·15″, the wind suddenly shifted from west-south-west to south-west, and came down with terrific violence, carrying everything before it. At midnight the wind shifted to south and began slowly to moderate. At 4 A.M. the engineer reported that the water had risen in the engine-room so far as to put the fires out. At 9 A.M. the wind shifted to south-east, and at noon the weather was improving rapidly and a moderate south-easterly breeze was blowing. The vessel continued to drift until the morning of the 2nd, when it was within sight of Madras. The *Sirsa* shortly afterwards came up and towed her into harbour. Five coolies were killed, and a large number injured by the rolling and pitching of the vessel during the night of the 31st. The *Bhandara*, it will thus be seen, remained in harbour until the inner storm area was approaching Madras and at once passed into it, and in the most dangerous quadrant. Hence she quickly became unmanageable, and was at the mercy of the storm. She passed, when nearest to the centre, 10 or 15 miles to the south, and hence, taking into consideration her course, was carried rapidly to the south by the currents when she left harbour.

The B. I. S. *Goorkha* was also in harbour at Madras on the morning of the 30th. The first, or warning signal, was hoisted before noon, and she left harbour at 5 P.M. and proceeded southwards. During the 31st she was at distances varying probably from 50 to 90 miles from Madras, and at no great distance from land. She was thus in the outer storm area, and her barometer only fell from 29·78″ at 4 P.M. of the 30th to 29·64″ at 4 P.M. of the 31st, when it was lowest. She had throughout moderate to strong breezes with heavy rain and frequent squalls. At 1 A.M. of the 1st the ship's head was turned to north, and she returned to Madras at 1 P.M. The captain of the *Goorkha*, by judiciously proceeding early to sea and adopting a southerly course, entirely avoided the strength of the storm.

The centre passed immediately to the north of Madras late in the evening (about 9-30 to 10 P.M.). A careful series of observations were taken at the Madras Port Office. The barometric and wind observations are charted in Plate XXXIV. The following account of the weather was furnished by the Port Officer: "The weather on the morning of the 30th had an unsettled appearance, but the barometer was steady, and did not, at that time, indicate the approach of a storm.

At noon the wind (from north) began to increase in force, and at 8 P.M. the barometer began to fall, at first very slowly. The weather became more unsettled during the night, with constant rain. The wind had now shifted to north-west and increased steadily in force. At noon of the 31st the weather was very stormy, and the barometer began to fall rather rapidly; the wind remained steady at north-west, and the squalls became more violent and were extremely severe between 6 P.M. and 9 P.M. There was a lull of half an hour from about 9-30 P.M. to 10 P.M., and almost immediately after 10 P.M. the wind began to come from east. The lowest reading of the barometer was taken very shortly after at 10-30 P.M. The wind now blew for some time in furious gusts from the east and then shifted to south-south-east, at which it remained for some hours. The weather moderated considerably before 8 A.M. The sea was not very heavy during the storm, and little or no damage was done to the harbour and foreshore. The greatest strength of the wind registered at the astronomical observatory was 46 miles an hour between 8 and 9 P.M. It rained continuously for 49 hours from 8 A.M. of the 30th to 9 A.M. of the 1st during which period a total amount of 14·23 inches was received." Squalls of force 8 were experienced at Madras from about 10 A.M. of the 31st, when the centre was probably nearly 150 miles distant, until 1 A.M. of the 1st. The rapid fall of the barometer which coincided with the period of frequent furious squalls of wind lasted from 6 P.M., (when the distance of the centre was probably about 40 miles), to about 2 A.M. These data, hence, enable approximate estimates of the diameters of the outer and inner storm area to be made. The outer storm area was from 200 to 250 miles in diameter from east to west, and the inner storm area 80 to 90 miles in diameter. These figures are, it will be seen, supported by the following accounts of the storm as experienced at the light-houses on the Madras Coast.

At Seven Pagodas Light-house, about 45 miles south of Madras, the weather, which had been previously fine, assumed a monsoonish appearance on the morning of the 30th. Heavy rain with moderate north-west winds prevailed from the afternoon of that day until about 7 P.M. of the 31st, when the wind freshened and gradually increased in violence till 11 P.M., when it began to blow a whole gale, which lasted till 3 A.M. At 4 A.M. the wind shifted to south-east and abated. This Light-house was probably just outside the inner storm area.

At the Pulicat Light-house, 30 miles to the north of Madras, similar weather was experienced. On the 30th it rained heavily all day, but the sea was smooth throughout the day. It rained very heavily and without intermission on the 31st, and the sea rose rapidly. At 4-30 P.M. (when the centre was about 60 miles to the east-south-east) the first heavy squall of wind was experienced. The wind increased in force till 1-25 A.M., when it veered to north-east 3 and blew very hard from that direction until 2-45 A.M., when it shifted to south-east.

At the Armaghan Light-house, 60 miles north of Madras, the weather was fair till 8 A.M. of the 31st, at which hour it became gloomy and the wind began to freshen up, and blow in gusts or squalls from the north. It increased gradually in force, and at 2 P.M. was blowing with much violence. It continued with unabated force till 3-30 A.M. of the 1st, when it began to abate. The following table gives the barometric readings taken during the storm :—

Date and hour.		BAROMETER.		Wind Direction.	Date and hour.		BAROMETER.		Wind Direction.
		Actual.	Corrected.				Actual.	Corrected.	
		Inches.	Inches.				Inches.	Inches.	
31st	8 A.M. .	29·83	29·77	N.-E.	31st	7 P.M. .	29·66	29·60	N.
	10 ,, .	·80	·74	N.		8 ,, .	·67	·61	N.
	2 P.M. .	·66	·60	N.		9 ,, .	·66	·60	N.
	3 ,, .	·65	·59	N.		10 ,, .	·65	·59	N.
	4 ,, .	·65	·59	N.		11-30 ,, .	...	...	E.
	5 ,, .	·66	·60	N.	1st	3-30 A.M. .	·70	·64	S.-E.
	6 ,, .	·66	·60	N.		6 ,, .	·74	·68	...

The barometric readings show clearly that the Light-house was in the outer storm area, where the barometer falls very slightly, although violent winds are experienced. The fall of the barometer from 10 A.M. to 10 P.M. (when it was lowest) was only ·15″, or very little more than the amount of the diurnal oscillation in India.

These facts, hence, show that the storm consisted of an inner storm area, which was probably not more than 80 to 90 miles in diameter, and of an outer storm area which extended to distances of 150 miles to north and west, and was approximately 250 to 300 miles in diameter. The depression at the centre when crossing the Madras coast was nearly one inch in amount.

It may be added that the force of the wind was powerful enough in the southern quadrant to overturn a train on the South Madras Railway at the Chingleput Tank, about 27 miles south of Madras. The accident occurred at 9-50 P.M. According to the guard's statement, the carriages were turned over very slowly, and none of the passengers were seriously injured. From the time of the accident up to 1-30 A.M. it blew so hard that it was impossible for the guard and passengers to leave the shelter of the carriages.

It is desirable to give the available data for the Arabian Sea and ascertain the weather conditions which prevailed in that area at this time. The following are noon observations of the 31st in that sea taken from logs of vessels :—

VESSEL.	POSITION.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Columbus . .	11—34	60—46	29·46	29·84	—·15	N.-W.	...	Squally weather, blowing very hard. Heavy sea in the afternoon.
Baghdad . .	16—10	60—10	30·04	·89	—·15	N.	...	Fresh breeze. Fine weather.
Dalhousie . .	16—16	61—25	29·98	·84	—·20	N.-N.-E.	4	Moderate north-east swell.
City of Canterbury .	16—34	63—29	30·08	·85	—·19	E.-N.-E.	6	Strong breeze. High confused sea.
Avoca . . .	17—4	69—57	...	...	...	Calm .	...	Overcast ; very rough sea.
Inishowen Head .	17—52	64—52	29·90	...	...	N.-E.	...	Strong monsoon.

Weather had been unsettled for some days off the Malabar coast, and a shallow depression, which extended a considerable distance westwards, overlay that coast from the 27th to the 30th. The shore observations appeared to indicate that it filled up on the 30th and 31st. The log of the *Columbus*, however, shows that weather was throughout the whole period from the 26th to the 31st very unsettled in the south of the Arabian Sea to the west of the Laccadives. The following gives the extract from her log for the 30th and 31st:—

DATE.	Hour.	POSITION AT NOON.		BAROMETER.		WIND.	Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Direction.	
30	4 A.M.					N.-N.-E.	Cloudy weather; fresh breeze.
	8 ,,					N.-N.-E.	Gloomy; fresh breeze.
	Noon.	11° 33′	60° 1′	29·49	29·87	N.-N.-E.	Cloudy weather; fresh breeze.
	4 P.M.					N.	
	8 ,,					N.	Squally weather.
	Midnight.					E.	Light wind.
31	4 A.M.						Misty weather and fresh breeze.
	8 ,,					N.-W.	Ditto.
	Noon.	11° 34′	60° 46′	29·46	29·84	N.-W.	Ditto.
	4 P.M.					N.-W.	
	8 ,,					N.-W.	Squally weather; blowing excessively hard. Rain ceased at 6 P. M.; 9 P. M. heavy sea running.
	Midnight.					N.-W. by N.	

Over the north and centre of the Arabian Sea, moderate to strong north-east winds prevailed. The Messageries steamer, which arrived at Aden from Colombo on the 5th, stated that in her passage between Minikoy and Socotra, she had throughout strong south-west winds and a very heavy sea, and the B. I. S. *Chyabussa*, which arrived at Aden from Colombo on the 6th, made an exactly similar report. Hence it is certain that strong south-west winds were blowing at this time over the south of the Arabian Sea, and moderate to strong north-east winds over the centre and north. Between these two areas was apparently an area of variable winds and squally weather. The *Columbus* was passing through this area on the 30th and 31st, and her log shows clearly the character of the weather there.

1st November.—The following table gives 8 A.M. observations at coast stations of the Bay and stations in Southern India:—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A. M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Port Blair	29·973	+·017	+·027	S.-S.-E.	11	157	88·0	+0·3	76·9	−0·6	5	Nil.	Cloudy; misty.
Diamond Island	·975	+·022	+·048	E.-S.-E.	13	144	88·3	+2·5	75·5	−1·0	3	—	Fine.
Saugor Island	30·006	+·030	+·088	N.-E.	9	150	89·2	+4·8	73·0	+0·6	8	—	Sea smooth.
False Point	29·987	+·028	+·024	E.-N.-E.	7	117	85·4	+1·2	76·1	+3·1	10	0·21	

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Gopalpur .	30·017	+·045	+·038	W.-N.-W.	9	129	79·7	?	74·8	?	8	0·69	Sea slight.
Vizagapatam .	29·961	+·039	+·056	N.-E.	2	100	78·4	−4·1	75·7	−3·2	10	1·10	
Cocanada .	·901	+·051	?	N.-E.	28	?	78·5	?	73·6	?	10	3·17	Sea rough.
Secunderabad .	·937	+·014	0	N.-E.	9	225	90·1	+6·5	70·9	+4·9	9	0·14	
Sholapur .	·925	−·021	−·015	E.-N..E.	19	238	91·7	+3·5	70·5	+5·8	7	—	Strong wind.
Belgaum .	·883	−·024	−·005	N.-N.-E.	7	58	88·3	+6·8	65·3	+1·6	3	—	Fine.
Bellary . .	·916	0	−·018	N.	10	333	92·4	+4·6	70·3	+1·5	10	0·13	
Cuddapah .	·777	−·093	?	?	?	?	80·0	?	72·2	?	10	1·38	Drizzling.
Kurnool .	·884	−·011	?	?	?	?	92·5	?	73·0	?	10	0·07	
Masulipatam .	·871	+·006	−·020	N.-N.-E.	31	620	79·5	−4·5	72·6	−1·8	10	2·50	Severe gale of wind.
Bangalore .	·849	−·064	+·008	N.-W.	5	125	77·5	−2·2	65·0	+0·5	10	0·50	
Mercara .	26·149	−·020	?	N.	5	125	77·3	+2·1	65·2	+2·8	9	—	
Wellington .	24·189	−·030	−·036	N.-W.	7	233	69·0	+1·9	55·5	−0·5	10	0·41	Drizzling.
Madras .	29·707	−·028	−·148	S.	32	457	79·0	−6·5	74·0	−0·1	10	6·92	Continuous rain.
Salem .	·869	−·041	−·066	N. W.	1	33	85·0	−3·2	70·0	+0·3	10	0·03	
Coimbatore .	·847	−·047	−·055	S.	4	133	86·3	+0·7	?	?	8	—	Fine.
Negapatam .	·790	−·018	−·072	S.-W.	5	100	89·0	+4·1	77·2	+2·8	9	0·08	Sea rough.
Trichinopoly .	·809	−·051	−·094	W.	7	175	90·0	+2·1	76·8	+3·9	10	—	Squally.

As stated above, the storm crossed the coast at Madras on the preceding night at 9-30 P.M. We have now to follow its course across the Peninsula. When it crossed the coast it was moving at a rate of about 10 miles per hour. The height of the barometer at the centre was 28·9″, and the direction of its motion west by north. Amongst the more remarkable features of the storm at this time were the very strong winds at distances of 200 miles and upwards to the north of the centre, and the comparatively feeble westerly winds at similar distances to the south-west of the centre. The 8 A.M. observations given above show that the centre of the cyclonic circulation was between Madras and Cuddapah, and nearer the former station. The whole of the observations, when charted, indicate that the centre was in Long. 79½° E. and in Lat. 13¼° N. It had not advanced more than about 45 miles since it crossed the coast at 9-30 P.M., and hence its average rate of motion barely exceeded 4 miles per hour. The barometer had risen eight-tenths of an inch at Madras, but was still lowest at that station. The extent of the storm in the northerly direction was shown by the fact that both Masulipatam and Cocanada experienced a very severe gale of wind, and the average wind velocity of the previous 24 hours was very nearly as great at those stations as at Madras, over which the centre passed. Winds were very light in the southern districts of Madras, thus showing that the indraught in the south-west quadrant was feeble and unimportant. The wind directions and the air motion were as yet unaffected on the Bombay coast, but over the remainder of the Peninsula the wind directions showed convergence to the central depression, and the cyclonic circulation hence included the greater part of the Bay and nearly the whole of the Peninsula. The winds were much stronger in the eastern and northern quadrants, and the stormy weather extended much further in these directions than to the west and south.

The following gives the average rainfall and the heaviest fall during the pre-
24 hours in each district of the Madras Presidency :—

DISTRICT.	Average rainfall in the district during previous 24 hours.	Heaviest rainfall in the district in previous 24 hours.	DISTRICT.	Average rainfall in the district during previous 24 hours.	Heaviest rainfall in the district in previous 24 hours.
eput	7·48	8·75	Bellary	0·56	0·72
pah	2·98	3·75	Tanjore . . .	0·49	2·30
. . . .	2·95	5·20	Nilgiris . . .	0·48	0·48
North) . . .	2·77	5·55	Trichinopoly . .	0·44	0·44
ri . . .	1·44	2·90	Vizagapatam . .	0·36	1·50
. . . .	1·14	2·50	Ganjam	0·27	0·89
r . . .	1·06	3·00	Madras . . .	0·20	0·20
pur . . .	0·98	1·00	Coimbatore . . .	0·12	0·35
l . . .	0·97	2·00	Canara (South) . .	0	0
South) . . .	0·70	2·10	Madura . . .	0	0
. . . .	0·59	1·90	Tinnevelly . . .	0	0

This table shows that the rainfall was excessive over the Chingleput district,
received an average of 7½ inches, and heavy, in the North Arcot, Nellore, and
apah districts. These were the districts through which the storm passed
the night of the 31st and morning of the 1st.

he following table gives the 4 P.M. observations at stations in the Penin-
nd on the coast of the Bay :—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
air . .	29·897	+·091	+·068	S.-S.-E.	10	143	2	Misty.
d Island .	·916	+·106	+·077	E.	7	78	5	
Island . .	·943	+·066	+·091	N.	9	150	9	Misty.
oint . .	·917	+·034	+·063	E.-N.-E.	12	200	9	
ur . . .	·926	+·041	+·077	N.-N.-E.	16	229	7	
patam . .	·900	+·032	+·072	N.	2	100	10	
erábad . .	·828	+·006	+·010	E.-N.-E.	15	375	10	
r . .	·802	-·003	+·002	N.-E.	22	275	10	Strong wind.
n . . .	·770	—·010	—·008	E.-N.-E.	26	217	10	Ditto.
. . .	·806	+·077	+·004	N.	11	367	10	
ah . .	·715	—·064	?	?	?	?	10	
l . . .	·805	+·025	?	?	?	?	10	
patam . .	·826	+·053	+·018	E.	10	200	10	
ore . .	·711	—·100	—·030	N.-W.	11	275	10	
. . .	26·057	—·038	?	N.	5	125	10	Drizzling.
ton . . .	24·127	—·028	—·031	N.	10	333	10	
. . . .	29·668	+·181	—·103	S.-S.-E.	22	314	9	
. . .	737	—·031	—·012	S.W.	3	100	9	
tore . .	·760	—·009	—·023	S.-W.	3	100	10	

he 8 A.M. observations have already indicated that the storm was filling up
y. It was then involved in the broken ground of the East Ghâts to the
of Cuddapah. The 4 P.M. observations show that the centre was, as at 8
between Madras, Cuddapah, and Bangalore. The wind and barometric
ations suggest that the centre was probably at nearly equal distances from

Bangalore and Cuddapah, and at a less distance from Madras than from eit these stations. The wind had backed from south to S. S. E. at Madras, was most probably due to the continued westward motion of the storm (It is hence very probable that the storm was 15 or 20 miles further to th at 4 P.M. than at 8 P.M., and hence that its position was in 13½° N. La 79½ E. Long. Its average velocity during the preceding 8 hours on this sition was less than 2½ miles per hour. It is hence certain that its advance the day was greatly retarded by the hill ranges in the Cuddapah, North Arc Kolar districts, and it was now not only advancing very slowly, but fill rapidly. Very strong winds were blowing across the Central Deccan, and B Sholapur, and Secunderabad now experienced the strongest winds (relati the normal). Ordinary north-east winds were again established on the coast as far south as Vizagapatam; weather was overcast over the Peninsul rain had extended westwards as far as Bellary and Secunderabad. It hitherto rainless over Southern India to the south of Lat. 11° N., and winds, light to moderate in that area.

The following table gives noon observations of the 31st taken on vessels in the Bay of Bengal:—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Peshwa	5—57	80—50	29·99	29·91	— 02	S.-W.	4	Fine clear weather.
Hajeem	Colombo.		...	...	...	W.-S.-W.	3	Dull and rainy.
Mount Tabor	12—3	83—47	...	...	...	S.-E.	6	Overcast.
Medea	12—44	80—28	·84	·79	—·10	S.-S.-W.	5	Clouded.
Goorkha	Madras.		·80	.85?	—·10?	S.	3	Moderate wind. Fin overcast sky.
Maharani	13—56	94—34	·92	·98	+·07	E.	3	Fine clear weather.
Ethiopia	16—47	82—24	·86	·95	+·06	E.	7	Hard squalls, with ra moderating
Dovenby Hall	19—54	89—42	30·10	30·00	+·12	N.-E. by E.	...	Fine weather.
Edmonton	21—03	87—35	...	...	...	...	...	Light squalls, with rai
Loch Torridon	21—21	89—4	·08	·02	+·13	N.-E.	3	Hazy.

They establish that the weather was rapidly improving in the south-w the Bay, and that it was squally only in the neighbourhood of the Circa North Coromandel coasts.

A large number of steamers have contributed meteorological informati pecting the weather in the Arabian Sea at this time. The following giv observations taken on board of vessels in the Arabian Sea on the 1st of nber :—

'ESSEL.	Position at Noon.		Barometer.			Wind.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
la . .	Off Vingurla.		29·85	29·93	+·01	E.	...	Light breeze and fine, with passing clouds. Moderate south-west swell.
. .	Kurrachee		30·06	30·03	—·09	N.	...	Light breeze and fine weather.
. .	At Abbas at 8 A.M.		·03	29·97	...	S.	...	Light to moderate head wind; fine clear weather.
z . .	7—26	77—38	29·93	·86	—·06	W.-N.-W.	...	Strong breeze and fine weather.
n . .	7—40	75—48	·90	...	...	Variable.	...	Fine clear weather.
. .	7—43	75—38	·90	·90	...	W.	...	Light airs and fine.
l . .	11—12	51—54	30·08	·95	...	N.-N.-E.	...	Moderate wind and fine clear weather.
us . .	12—26	62—34	29·28	·66	—·27	N.-W.	..	Morning, blowing hard and thick, with rain; heavy sea. Noon, clear weather.
. .	14—33	53—26	30·05	30·00	—·04	N.-E.	3 to 4	Moderate breeze and fine throughout.
. .	14—46	55—13	·06	29·94	—·10	N.-N.-E.	2 to 3	Fine.
. .	15—2	66—37	...	...	...	E.	...	Evening, fresh south-west breeze; very rough sea and very hard squalls.
ie . .	15—11	57—41	·05	·91	—·13	N.-E.	4	Moderate north-east swell.
l . .	15—20	56—20	·05	·91	—·05	N.-N.-W.	...	Moderate breeze and sea. Fine clear weather.
a . .	15—28	57—18	29·85	·89	—·07	N.-E.	...	Strong winds and squally, with heavy swell from the north-east.
. .	17—18	71—4	·86	·85	—·11	N.-E.	...	Light breeze from east.
anterbury	17—37	66—56	30·12	·89	—·14	E.-N.-E.	4	Rolling violently in confused cross sea.
n Head .	18—35	67—57	29·94	·86	—·17	N.-E.	...	Fresh breeze and fine clear weather.
lie .	...	...	...	...	...	N.-E.	...	Light breeze; cloudy weather with head swell.

iese observations are very important, as they show the continuance of and perhaps stormy weather over a large area in the centre of the Arabian d also that this disturbance was in no way directly connected with the storm g the Peninsula. A reference to the chart of 1st November (Plate XXXVI) ow at once that this area extended from about Lat. 8° N. to Lat. 16° or and from Long 60° E. to 68° E. As already pointed out in the remarks 31st, strong north-east winds prevailed to the north of this area, and te to strong south-west winds to the south.

e *Columbus* was near to the centre of this intermediate area and in Lat. N. and Long. 62° 34′ E. at noon. In the morning it was blowing hard from h-west and heavy rain was falling. The weather cleared up in the after- hen the wind shifted to south and then to south-east. The *Avoca* was es to the east-north-east of the *Columbus* in Lat. 15° 2′ N. and Long. 66° In the morning she had an easterly fresh breeze and in the afternoon south-west breeze, very hard rain-squalls, and a very rough sea. The

Inchborva entered this area during the day. The following is the weather experienced by that vessel:—

4 A.M.—Wind north-east—strong breeze, heavy head swell.
8 A.M.—Wind and sea increasing.
Noon.—Strong winds and squally, with heavy sea from north-east.
4 P.M.—Ship taking much water on board.
Midnight.—Fresh gale.

The *Serapis* was 100 miles further west than the *Inchborva*. Her log notes that the wind increased in force from 2 in the morning to 6 at midnight. Similarly the *Clyde*, about 100 miles west of the *Serapis*, had light north-east winds (force 1), and fine weather in the morning and a fresh north-east monsoon (force 5 to 6) at midnight.

This intermediate area, about 700 miles in length from east to west and 300 miles in breadth from north to south, was evidently one of disturbed and squally weather. There was no vessel near the centre of the area, and the information is hence imperfect. It shows that pressure was very low, that there was a tendency towards the establishment of cyclonic motion, and that strong winds with frequent heavy rain-squalls and a high sea certainly prevailed in the northern and southern outskirts of the area, and probably over the whole area. The logs of the *Columbus* and *Avoca* also show that in the eastern portion of the area southerly winds were pressing forward or advancing. This fact, taken into consideration with the strong north-east winds prevailing in the western portion of the area, indicated a very strong tendency for the squally weather to develop into a cyclonic circulation. It was, however, an extensive but diffused disturbance, and lacked the concentration necessary for a cyclonic storm or cyclone.

Weather was on the other hand fine with light to moderate winds off the Bombay coast, and also to the north and west of the area of squally weather in the centre of the Arabian Sea.

We have next to examine the weather off the Malabar and Konkan coasts in order to ascertain whether the storm crossing the Peninsula on this day began to affect the weather in the Arabian Sea during the day or not. The following table gives the whole of the information contained in the logs of five coasting steamers:—

VESSEL.	Hour.	POSITION OF SHIP.		BAROMETER.		Wind.	Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.		
Lalpoora	4 A.M.	...	...	29·90	29·83	W.	Strong breeze; sky overcast.
	8 A.M.	...	...	·92	·85	W.-N.-W.	Strong wind; moderate sea.
	Noon	7° 26′	77° 38′	·93	·86	W.-N.-W.	Strong breeze; fair weather.
	8 P.M.	...	...	·90	·83	W.-N.-W.	Strong breeze; occasional rain-squalls.
	Mid.	...	...	·92	·85	W.-N.-W.	Ditto ditto.

VESSEL.	Hour.	POSITION OF SHIP.		BAROMETER.		Wind.	Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.		
Matheson	4 A.M.	...	...	29·94	...	W.-N.-W.	
	Noon and Mid.	7° 40′	75° 48′	·90	...	Variable throughout.	Light variable winds and fine clear weather; 8 P.M., fresh unsteady breeze; midnight, heavy rain, squally.
Coconada	4 A.M.	Off Ratnagiri		·80	29·88	E.	Light breeze and fine, with passing clouds.
	Noon	Off Vingurla		·85	·93	E.	Light breeze and fine; moderate south-west swell.
	4 P.M.	...	...	·76	·84	N.-W.	Moderate land breeze and passing showers.
	8 P.M.	Anchored at Marmagoa Bay				...	Fine weather.
Canara	8 P.M.	Left Bombay in afternoon for Mangalore.				Land and sea breeze	Light breeze; fine weather.
	Midnight	...	...	...	...	N. by E.	Light breeze. Sky overcast at times.
Castor (Barque)	Noon	17° 18′	71° 4′	·86	·85	N.-E.	Light breeze and clear.
	7 P.M.	...	...	...	...	N.-E.	Moderate breeze and cloudy.

The observations taken on board the *Lalpoora* show that between the West Ceylon coast and the main land weather was squally and rainy. Further to the west, as experienced by the *Matheson*, winds were variable. Along the Bombay and Konkan coasts weather was fine, with light winds and clear skies, until the evening, when clouds began to gather.

The following gives a brief summary of the weather conditions on the evening of the 1st of November in the Arabian Sea. Over the north and north-west weather was fine, with light to moderate north-east winds. In the south, south-west or variable winds prevailed. These areas were separated by an intermediate area in the centre, in which pressure was lowest, weather was squally with strong winds, and there was a tendency towards the establishment of cyclonic air motion on the large scale. This intermediate area was however most probably one of diffused squally weather, without the concentration which marks a cyclonic storm, and, in fact, such as frequently forms the initial stage of a cyclonic storm, and which may, if conditions are favourable, develop into a cyclone. Weather was fine off the west coast of India as far south as Cochin. Between Cape Comorin and Ceylon it was squally, but this was very probably caused by the indraught to the storm in the Peninsula. There was no change in the weather in the Malabar coast districts during the evening and night, such as usually occurs on the approach of a cyclonic storm. This is fully proved by the Cochin and Mangalore observations.

2nd November.—The following gives 8 A.M. observations for this day:—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.						
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.	Cloud proportion.	Rainfall in past 24 hours.	Weather.
Bombay	29·896	−·037	−·024	E.-N-E.	11	110	92·4	+3·7	80·0	+4·4	8	—	Fine.
Ratnagiri	·852	−·022	−·047	N.-N.-E.	11	112	96·4	+6·2	77·9	+5·7	4	0·04	Do.
Sholapur	·916	−·009	−·023	E.-N.-E.	21	263	92·2	+4·6	73·0	+7·2	6	0·05	Strong wind.
Secunderabad	·965	+·028	+·001	E.-N.-E.	12	300	77·1	−6·6	69·4	+2·7	10	0·06	
Belgaum	·834	−·049	−·072	N.-E.	23	192	87·2	+5·2	68·3	+4·0	10	—	Strong wind.
Karwar	·787	−·079	−·130	N.	?	?	89·3	+3·2	75·7	+3·6	10	0·15	Distant lightning.
Goa	·801?	−·152?	+·015?	N.-E.	?	?	93·0	?	77·0	?	9	—	Fine.
Bellary	·873	−·043	−·027	E.	12	400	74·5	−13·2	71·3	+1·9	10	0·97	
Kurnool	·904	+·020	?	?	?	?	75·5	?	73·0	?	10	0·53	Showery.
Cuddapah	·862	+·085	?	?	?	?	82·0	?	73·2	?	10	2·30	
Madras	·867	+·160	−·028	S.-S.-E.	9	129	84·5	−0·9	75·0	+1·2	9	0·80	Showery.
Bangalore	·880	+·031	+·048	E.	11	275	66·9	−12·8	65·5	+1·0	8	3·92	Continuous rain.
Mangalore	·739	−·143	−·113	N.-E.	5	167	85·8	−0·1	77·4	+3·1	10	0·12	Threatening.
Mercara	26·054	−·095	?	E.-S.-E.	5	125	77·8	+3·3	62·7	+0·7	10	0·89	Showery.
Wellington	24·183	−·006	−·028	Calm	4	133	66·0	−0·5	53·5	−2·7	10	0·10	Strong wind.
Coimbatore	29·866	+·019	−·025	S.-W.	3	100	81·4	−4·5	?	?	3	0·19	Fine.
Salem	·896	+·027	−·023	W.	2	67	84·5	−3·0	69·0	−0·9	4	0·02	Do.
Calicut	·849	−·024	−·057	S.-E.	8	?	85·3	?	74·5	?	10	1·07	Drizzling.
Trichinopoly	·868	+·059	−·020	E.-N.-E.	4	100	90·0	+2·2	74·4	+1·7	8	0·44	Squally.
Negapatam	·854	+·064	−·089	Calm	3	60	88·0	+3·0	74·7	+1·0	10	0·10	Sea rough.
Cochin	·863	+·001	−·017	N.-E.	0	0	84·2	−1·3	73·7	−0·3	10	3·92	Ditto.
Colombo	·904	+·010	−·024	W.-S.-W.	10	167	88·5	?	78·0	?	10	0·02	Raining.
Trincomalee	·868	+·022	−·087	S.-W.	4	57	95·0	?	76·0	?	4	—	

The barometric changes of the previous 24 hours were small in amount in Northern and Central India. Skies were clear in the Punjab and adjacent districts of Rajputana and the North-Western Provinces, but were more or less clouded in all other districts. The only important feature in the weather was the disturbance which was crossing the Peninsula on the previous evening. The barometer had risen rapidly on the Coromandel coast and was falling quickly on the Malabar and Konkan coasts. The observations, more especially those of Goa and perhaps Mangalore, are doubtful. The former must certainly be rejected. The large fall at the latter is supported by a somewhat smaller fall at the neighbouring hill station of Mercara, and hence is on the whole probably correct. Assuming it to be correct, the fall of the barometer was greatest at Mangalore. Easterly winds were blowing across Mysore and the Deccan. There was no trace of a residual cyclonic circulation in the Peninsula. On the other hand, the wind directions at Calicut (south-east) and at Mangalore (north-east) appear to indicate the existence of a cyclonic circulation over the area of depression off the Malabar coast, the existence of which is suggested by the Mangalore barometric reading. The wind further south at Cochin was from north-east, and hence, if there was a cyclonic circulation, it was not only feeble, but of very small extent.

The important question hence arises: Was the depression off the South Konkan coast, the chief indication of which was given by the 8 A.M. Mangalore barometer reading of this day, the direct continuation of the storm which was drifting very slowly westwards in the area between Cuddapah, Madras, and Bangalore on the previous evening? So far as can be judged from the observations, the storm at that time had filled up very considerably, and was moving very slowly to the west-north-west at a rate probably not exceeding 2 miles per hour. It was approaching the broken ground and hills of the Cuddapah, North Arcot, and Bellary districts and North-east Mysore. If it had advanced as an unbroken and continuous storm into the Arabian Sea off Mangalore, it must have moved through a distance of at least 300 miles between 4 P.M. of the 1st and 8 A.M. of the 2nd, or marched at an average rate of at least 19 miles an hour during this period of 16 hours. It must also have recurved slightly from west to west by south or west-south-west during the night. Storms in recurving, however, generally move more slowly than they do previous to recurving. If it advanced in that track, it must have moved with this unusually large velocity across the high land of the Mysore plateau and the West Ghâts in Coorg, ranging in elevation from 2,000 to 5,000 feet. It appears to be very improbable that it should, after having had its rate of motion on its old track largely decreased when advancing to the low East Ghâts and Mysore plateau, have suddenly increased its velocity and advanced during the night at a rate probably exceeding 20 miles per hour in a different direction and crossed the high West Ghâts unbroken.

These facts appear to establish that it is very probable that the Mangalore depression of the morning of the 2nd, if real, was not the direct continuation of the cyclonic storm of the 1st. The following additional evidence appears, however, to prove it conclusively.

The first is based on the consideration of the 4 P.M. observations at the stations given in the following table:—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Bombay	29·754	—·043	—·056	N.-N.-W.	11	110	19	
Ratnagiri	·714	—·057	—·067	E.-N.-E.	18	200	2	
Sholapur	·783	—·005	—·002	N.-E.	24	300	9	Squally.
Secunderabad	·821	+·006	+·020	E.-N.-E.	7	175	9	
Belgaum	·766	—·034	—·043	E.	37	308	10	Strong wind.
Karwar	·691	—·082	—·090	N.	?	?	10	
Bellary	·762	—·013	—·008	E.	9	300	9	
Kurnool	·805	+·011	?	?	?	?	6	
Cuddapah	·773	+·065	?	?	?	?	7	
Madras	·778	+·110	+·008	S.-S.-E.	5	71	5	
Bangalore	·771	+·106	+·076	E	5	125	6	
Mangalore	·733	—·050	—·052	S.-S.-E.	8	266	10	
Mercara	26·044	—·013	?	S.	7	175	10	
Wellington	24·151	+·024	—·007	S.-E.	2	66	8	
Coimbatore	29·773	+·018	—·008	W.-S.-W.	7	233	5	
Salem	·766	+·037	+·014	N.-W.	1	33	6	
Calicut	·768	—·001	—·037	E.-S.-E.	6	?	10	
Trichinopoly	·732	+·049	—·040	E.	5	125	8	
Negapatam	·764	+·044	—·005	S.-E.	5	100	7	
Cochin	·783	—·001	—·008	S.-E.	?	?	10	

These observations (*vide* Plate XXXIII) indicate that the barometer was at that hour much lower at Karwar than at any other port on the west coast. Hence there was now a barometric depression off the Karwar coast, and the winds at Karwar (north), Belgaum (east), and Mangalore (south-south-east) indicate that there was an irregular cyclonic circulation over the area defined by these stations. It may be stated that the observations at Karwar and Mangalore are recorded by trustworthy observers, and that equal values or weights are usually given to their observations in the India Meteorological Office. The 8 A.M. and 4 P.M. observations at these two stations, if they be accepted as correct and equally trustworthy, indicate that a shallow depression advanced in a northerly direction along and near the coast of the Konkan from Mangalore to Karwar, and if this were the continuation of the storm of the 1st in the North Coromandel coast districts, it must have hence recurved during the previous 24 hours, first from west to west-south-west, and afterwards from west-south-west to north, and travelled during the interval between 8 A.M. and 4 P.M. at the rate of at least 16 miles per hour, as the distance between Mangalore and Karwar is 130 miles.

The distance between the base of the West Ghâts and the ports of Karwar and Mangalore is not more than 10 or 15 miles. If the storm crossed the West Ghâts in Coorg, it would then be at an elevation of 5,000 feet and upwards. Hence it is exceedingly improbable that the storm would descend to the sea-level in the space of a few miles, and show itself there as a well-defined cyclonic circulation and storm. It is a well-known fact that the West Ghâts protect the west coast ports most effectively against large storms passing westwards across the Peninsula.

The evidence for the passage of the storm across the Ghâts into the Arabian Sea is hence to be sought from the observations in the sea area off the Malabar coast, where the storm would have descended from its previous altitude when crossing the West Ghâts to the level of the sea, rather than from those taken at the coast stations.

The following table gives the whole of the meteorological information contained in the logs of vessels near the Malabar and Konkan coasts on the 2nd :—

VESSEL.	Hour.	Latitude, North.	Longitude, East.	BAROMETER.		WIND.		Weather.
				Actual.	Corrected.	Direction.	Force.	
		° ′	° ′					
Lalpoora	4 A.M.			29·98	29·81	S.-W.	...	Strong breeze; occasional hard squalls.
	8 A.M.			·93	·76	Variable	...	Moderate breeze. Heavy squalls.
	Noon.	9—51	75—44	·94	·78	Variable	...	Light and variable winds. Heavy rain.
	4 P.M.			·90	·75	Variable	...	Light airs; rain-squalls.
	8 P.M.			·94	·77	Variable	...	Light airs and cloudy.
	Mid.			·94	·75	Variable	...	Ditto.
Canara	1 A.M.					E.-S.-E.		Fine weather.
	2 ,,					S.		Ditto.
	4 ,,			·89	·81	Variable	...	Fine weather; light winds.
	8 ,,	Off Ratnagiri.		·93	·85	S.-E.	...	Moderate breeze.
	Noon.	16—21	73—13	·86	·78	S.-E.	...	Fine weather; light breeze.
	4 P.M.	Off Vingurla.		·81	·73	E.-S.-E.	...	Fine clear weather.
	8 ,,			·87	·79	E.	...	Strong breeze; light rain.
	Mid.	Off Karwar.		·86	·78	S.-E.	...	Strong wind; squally with rain.

Vessel.	Hour.	Latitude, North.	Longitude, East.	Barometer.		Wind.		Weather.
				Actual.	Corrected.	Direction.	Force.	
		° ′	° ′					
Nur Jahan	1 A.M.					N.-E.	2	
	3 ,,			29·99	29·89	S.-S.-E.	3	Gentle breeze and fine.
	7 ,,					S.-E.	2	Light breeze and fine.
	8 ,,			·98	·87	N.-E.	2	
	Noon.	16—40	73—08	·97	·86	E.	2	South breeze. Fine cloudy weather.
	2 P.M.	Off Ratnagiri.		·92	·81	E.-S.-E.	2	
	8 ,,	Off Vingurla.		·92	·80	S.-E.	4	Moderate breeze; cloudy, with light rain.
	11 ,,	Off Goa.		·92	·81	S.-S.-E.	5	Fresh breeze; cloudy and showery.
Coconada	8 A.M.	Left Goa for Bombay.		·76	·76	N.-E.	...	Fresh breeze; squally appearance over land.
	Noon.	Off Vingurla.		·76	·76	N.-E.		Ditto.
	8 P.M.	Off Ratnagiri.		·78	·78	...	...	Dark and squally, with rain.

The *Lalpoora* was advancing northwards during the day along the Malabar Coast and the *Canara* and *Nur Jahan* southwards along the coast of the Konkan. The barometric observations of these vessels show no fall of the barometer, such as would occur if a cyclonic storm passed over them. The winds during the day were light and variable, more especially off the Malabar coast. The wind directions cannot be explained by the passage of a cyclone northwards off the coast. All that the observations show is that the weather became squally towards evening, and that moderate south-east winds prevailed off the Konkan coast.

Hence it appears to be established that the cyclonic storm which crossed the Madras coast on the night of the 31st did not pass as an unbroken storm or well marked and strong cyclonic circulation westwards across the West Ghâts into the Arabian Sea, but that it broke up near the hills of East Mysore on the night of the 1st.

It is necessary to point out that the observations contributed by one vessel, the S. S. *Maria*, appear opposed to this conclusion. They are given in full for the 1st, 2nd, 3rd, and 4th:—

Date.	Hour.	Latitude, North.	Longitude, East.	Direction.	Weather.
		° ′	° ′		
1st	Noon.	...	...	S.-E.	
	Midnight.	...	...	E.-S.-E.	
2nd	1 to 4 A.M.	...	...	Variable winds.	Squally.
	6 A.M.			N.-N.-W.	
	Noon.	13—59	69—16	...	Squally.
	1 P.M.	...	...	N. by W.	Strong breeze and squally.
	8 P.M. to midnight.	...	...	...	Very squally.
3rd	1 A.M. to 3 A.M.	...	...	N.-E.	Strong breeze; squally, with rain.
	4 A.M.	...	...	...	Storm from 4 A.M. to noon.
	8 ,,	...	...	E.-N.-E.	
	Noon.	15—7	70—5	...	
	1 P.M.	...	...	E.	Very strong breeze and stormy.
	4 ,,	...	...	...	Moderate breeze; squally.
4th	1 A.M. to 4 P.M.		...	E.-S.-E.	Squally.
	4 A.M. to noon.			...	Squally, with rain.
	Noon.	17—30	70—42	...	

No barometric observations nor estimates of wind force are given in the log, hence the observations are of little value and cannot be utilized to decide this doubtful question. They certainly seem to show that the *Maria* encountered a small storm in about Lat. 15° N. and Long. 70° E. on the morning of the 3rd. As the vessel hove-to during the storm, the changes of wind, if due to the passage of a cyclonic storm, indicated that it passed to the south of the vessel in a westerly or west-north-westerly direction. But this position is about 650 miles in a direct line to the west by north of the position of the storm at 4 P.M. of the 1st. It certainly gives a position nearly in the direct continuation of the line of march when it crossed the Coromandel coast, but the velocity of at least 18 miles per hour required to cover this distance is greater than that in any previous cyclonic storm crossing the West Ghâts into the Arabian Sea, of which we have any account. On the other hand, the shore and ship observations establish conclusively that if a storm or disturbance was transmitted westwards, it did not march in a straight and continuous course from the Madras coast across the West Ghâts into the Arabian Sea. In the absence of other observations the most probable supposition is that if the *Maria* encountered a cyclonic storm, it was not the direct continuation of the cyclonic storm of the 1st. If, however, it be assumed that the Madras cyclone broke up on the night of the 1st, it is almost certain that the general disturbance, of which the cyclonic storm formed the kernel, did not break up entirely, but was transmitted rapidly westwards, and that this gave rise to squalls in the afternoon and evening of the 2nd on the coast of the Konkan, and probably to the so-called storm which the *Maria* encountered on the morning of the 3rd, and which was, perhaps, a succession of squalls, and not a cyclonic storm proper. This conclusion seems to be most consistent with the facts. It is supported by the results of previous experience, which establish that whilst storms of the rains proper or during the period 1st June to 15th or 30th September have a remarkable power of surmounting hill ranges with little or no loss of energy, the more severe cyclones of May, October, and November have very feeble powers in this respect. In the great majority of cases, when they advance towards a line of hills they either break up or are deflected. It is sufficient to state the examples of the Backerganj cyclone in 1876, the Akyab cyclone of May 1884, &c.

The following table gives the noon observations for the 2nd extracted from the logs of vessels in the Arabian Sea:—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Patna	5—54	80—29	30·00	...	...	Variable.	2	Heavy rain at times.
Manora	Colombo		29·92	...	...	W.-S.-W.	...	...
Lalpoora	9—51	75—44	·94	29·78	—·14	Variable.	...	Heavy rain. Light to moderate breezes.
Oriental	12—20	48—37	30·10	·97	—.05	Calm	...	Fine.
Avoca	13—03	63—34	...	...	...	S.-W.	...	Rough sea.
Columbus	13—52	64—10	...	...	...	S.-E.	...	Light airs.
Maria	13—59	69—16	...	...	...	N.-N.-W.	...	Squalls.
Baghdad	14—14	52—40	·05	·90	—·14	N.-W.	...	Light to moderate breezes; fine weather.

Vessel.	Position at Noon.		Barometer.			Wind.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Dalhousie . . .	14—20	54—06	30·07	29·93	—·11	N.-N.-E.	4 to 5	Overcast.
Drumbarlie . .	15—28	57—35	·50	...	...	N.-E.	...	Strong wind and high cross sea.
Serapis . . .	15—36	59— 3	·92	·76	—·29	E -N.-E.	7 to 5	Fine weather.
Clyde . . .	15—40	57—30	·85	·80	—·25	N.-E.	6 to 7	High easterly swell and confused sea.
Inchborva . .	15—53	59—23	·65	·79	—·26	E.-N.-E.	...	Strong wind and clear.
Canara . . .	16—21	73—13	·86	·80	—·12	S.-E.	...	Fine weather and light breeze.
Nur Jahan . .	16—40	73—08	·97	·87	—·06	N.-E.	...	Gentle breeze and cloudy weather; south-west swell.
Castor . . .	17—57	72— 1	·84	·83	—·13	N.-E.	...	Light breeze; clear weather.
Coconada . .	Near Murmagoa.		·76	·84	...	...	...	Fresh breeze; overcast and squally.
Knight Errant .	18—48	72—3	...	...	...	N.-W.	...	Moderate breeze; sea smooth.
Inishowen Head .	18—55	72— 8	29·96	...	...	N.-E.	...	Moderate wind and fine.
Yesso . . .	19—27	71— 3	30·00	·90	—·09	N.-E.	...	Moderate and clear.
Hensada . . .	23— 9	64—43	·00	...	...	N.	3	Fine weather.
Purulia . . .	23—41	58—32	·06	30·00	—·05	S.-E.	...	Ditto.
Assyria . . .	24—47	66—30	·03	·00	—·11	Calm	...	Fine weather; sea smooth and light airs.

They show that over the Arabian Sea to the north of Lat. 16° or 17° N. fine clear weather with moderate north-east winds prevailed. In the centre of the Arabian Sea, between Lat. 12° and 16° N. and Long. 54° to 64° E., the weather was even more stormy than on the 1st. The *Serapis*, *Clyde*, *Inchborva*, and *Drumbarlie* passed into the area on the previous evening. These four vessels were advancing eastwards along the usual steamer track between Aden and Bombay, and were within 100 miles of each other at noon of the 2nd. The following gives the whole of the weather information in their logs for this day and also that contained in the logs of the *Avoca* and *Columbus* :—

Vessel.	Hour.	Position.		Barometer, corrected.	Wind.		Weather.
		Latitude, North.	Longitude, East.		Direction.	Force.	
		° ′	° ′				
Clyde . .	1 A.M. .	...	56—40	29·84	N.-N.-E.	5 to 6	Fresh increasing wind; cloudy.
	4 ,, .	...	...	·80	N.-E.	6	Strong wind and cloudy weather.
	6 ,, .	...	...	·80	N.-E.	6 to 7	Furious squalls of wind and rain.
	8 ,, .	...	...	·81	N.-E. to N.	6	Strong breeze to moderate gale, with heavy rain-squalls at times.
	9 ,, .	...	...	·81	N -E. to N.	6	High easterly swell and confused sea.
	Noon .	15—40	57—30	·80	N.-E.	6 to 7	Ditto ditto.
	1 P.M. .	...	...	·77	N.-E. to E.	6 to 7	Ditto ditto.
	4 ,, .	...	...	·74	N.-E. to E.	...	Strong wind; cloudy weather; high confused sea.
	8 ,, .	...	...	·83	N.-E. to E.	...	Strong breeze; overcast; high confused sea.
	Mid. .	16—15	59—05	·87	N.-E. to E.	5 to 6	Wind and sea decreasing slightly.

Vessel.	Hour.	Position.		Barometer, corrected.	Wind.		Weather.
		Latitude, North.	Longitude, East.		Direction.	Force.	
		° ′	° ′				
Inchborva	1 A.M.	...	...	...	N.-E.	...	Gale increasing; very heavy cross sea.
	3 ,,	...	...	...	N.-E.	...	Gale increasing.
	4 ,,	...	...	...	E.-N.-E.	...	Ditto
	5-30 A.M.	...	...	...	E.-N.-E.	...	Gale moderating.
	8 A. M.	...	...	...	E.-N.-E.	...	Heavy rain-showers.
	Noon	15—53	59—23	29·79	E.-N.-E.	...	Strong winds; clear.
	Mid.	...	...	...	E.-N.-E.	...	Strong winds and overcast.
	1 A.M.	...	...	...	E.-N.-E.	...	Moderate gale. High cross sea.
Drumbarlie	4 ,,	...	...	...	E.-N.-E.	...	Wind and sea increasing.
	7 ,,	...	...	...	E.-N.-E.	...	Strong gale with high cross sea; vessel shipping tremendous seas.
	Noon	15—28	57—35	...	N.-E.	...	Ditto ditto.
	2 P.M.	...	...	...	...	...	Wind and sea moderating.
	4 ,,	...	...	...	N.-E.	...	Strong wind; nasty cross sea.
	Mid.	...	...	...	N.-E.	...	Fresh breeze; sea high.
Serapis	2 A.M.	...	...	29·80	N.-N.-E.	8	
	4 ,,	...	...	·67	N.-E.	6 to 8	
	8 ,,	...	..	·74	N.-E.	7	Sea rough.
	Noon	15—36	59—3	·76	E.-N.-E.	5 to 7	
	4 P.M.	...	...	·75	E. by N.	4	Sea moderate.
	8 ,,	...	...	·85	E. by N.	4	
	Mid.	...	...	·84	E. by N.	3 to 4	Sea smooth.
Avoca	Noon	13—3	63—34	...	S.-W.	...	Fresh breeze; rough sea.
Columbus	4 A.M.	...	...	...	S.-E.	...	Fine clear weather; light breeze.
	Noon	13—52	64—10	...	S.-E.	...	Light airs.
	1 P.M.	...	...	...	S.-W.	...	Very light airs.
	3 ,,	...	...	...	Variable	...	Cloudy weather.
	5 ,,	...	...	...	W.	...	
	7 ,,	..	...	...	Variable	...	Cloudy weather.
	Mid.	...	...	...	W. to N. W.	...	Light airs and smooth sea.

These extracts show clearly the character of the weather in the area of disturbance in the centre of the Arabian Sea. In the western portion very strong north-easterly winds with heavy to furious squalls were blowing. In the eastern portion, the weather was less disturbed and moderate to strong south-east to south-west winds prevailed. The accurate series of barometric observations taken on board the *Clyde* and *Serapis* show that the barometer fell very slightly as they passed through the area. The most remarkable feature of the disturbance was that the strongest winds were from north-east and the most violent squalls were experienced by the *Clyde* and *Inchborva*, shortly after entering the disturbance on the western side. As these two vessels passed eastwards the winds veered from north-east to east-north-east and then to east and gradually moderated. So far as can be judged from the evidence, the southerly winds in the opposite quadrant were comparatively feeble.

Hence, the data appear to establish that although there was much disturbance in the intermediate area lying between a large area of north-east winds to the north and of south-westerly winds to the south, and consequently a marked tendency towards the establishment of a cyclonic circulation, the disturbance on the 2nd as on the 1st was diffused in character. The weather was such as occurs in fact in the initial stages of a cyclonic storm, when it is not possible to assign a definite position to the centre of such a disturbance. It is however clear that the most disturbed weather on the 2nd in the Arabian Sea occurred in this central area and not in the neighbourhood of the Malabar or Konkan coasts.

The chief feature in the Arabian Sea was a wide trough or belt of deficient pressure stretching from 54°E., to the coast of the Konkan and from Lat. 10°N. to Lat. 18°N, which separated an area to the north in which northerly to north-easterly winds prevailed, from one to the south in which south-westerly to westerly winds prevailed. In the intermediate area the weather was more or less squally, with strong unsteady and variable winds and frequent rain showers. This area of shallow barometric depression approximately coincided in position with a corresponding area present in the Arabian Sea on the previous day (the 1st), and was undoubtedly the continuation of that feature. The only important change was the extension of the area eastwards to the Malabar and Konkan coasts. This extension had accompanied the breaking up of the cyclonic storm in the peninsula. As the weather was squally off the Malabar coast, it is probable that the breaking up of the storm in the Carnatic was followed by the rapid passage of a slight disturbance across the Ghâts into the Arabian Sea which was absorbed into, and formed part of, the general disturbance in this area on the 2nd.

In the north and north-west of the Arabian Sea fine clear weather with light to moderate winds prevailed.

November 3rd.—The following table gives 8 A.M. observations at stations on and near the west coast of India:—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.						
	Actual, reduced to sea level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.	Cloud proportion.	Rainfall in past 24 hours.	Weather.
Cochin . .	29·909	+·046	+·005	Calm.	0	?	81·7	—4·7	73·7	—0·3	10	1·14	
Wellington .	24·241	+·058	—·006	Calm.	1	33	66·5	—1·9	54·0	—1·5	10	0·04	Showery.
Mangalore .	29·900	+·161	—·020	S.	4	133	79·8	—6·0	74·4	+0·3	10	3·05	Sea rough.
Mercara . .	26·158	+·104	?	S.	5	125	77·3	+2·2	63·7	+1·5	9	0·24	Showery.
Calicut . .	29·893	+·044	—·023	Calm.	5	?	80·8	?	73·5	?	10	1·44	Sea smooth.
Karwar . .	·843	+·056	—·047	W.	?	?	88·8	+3·0	75·7	+3·8	10	0·09	Sea rough.
Belgaum . .	·870	+·036	—·014	E.-S.-E.	27	225	78·7	—4·0	68·8	+4·8	10	0·03	Severe gale of wind.
Goa . .	·903?	+·102?	—·00[illegible]?	E.	?	?	91·0	?	78·0	?	10	—	Fine.
Ratnagiri .	·849	—·003	—·048	E.	13	144	98·4	+7·7	77·4	+5·3	6	—	Do.
Bombay . .	·859	—·037	—·056	N.-E.	12	120	94·9	+7·0	82·0	+6·5	8	—	Do.
Poona . .	·913	—·045	—·031	E.	13	217	91·1	+3·7	71·9	+8·0	7	—	Do.
Sholapur .	·917	+·001	—·016	E.	21	263	90·2	+2·6	70·5	+4·2	6	—	Strong wind.
Surat . .	·884	—·061	—·045	S.-W.	?	?	96·2	+3·9	74·0	+8·4	1	—	Fine.
Malegaon .	·950	—·049	—·036	N.-E.	4	100	87·9	—0·2	70·2	+10·1	8	—	Do.
Rajkot . .	·917	—·004	—·044	E.	3	60	94·4	+1·5	61·4	—0·4	0	—	
Deesa . .	·955	—·052	—·042	E.-N.-E.	7	88	94·3	+1·3	59·9	+0·3	1	—	Fine.

Pressure had increased in Bengal, Burma, and the south of the Peninsula and had fallen elsewhere. The most important changes occurred on the west coast. The barometer had risen rapidly on the Malabar coast and was falling on the North Bombay coast. Pressure was lowest at Karwar, and the winds were from opposite directions at Karwar (W.) and Goa (E.). These facts appeared to indicate the existence of an area of depression off the west coast which was travelling northwards nearly parallel to the coast. Very strong easterly winds were blowing in the West Deccan. Belgaum recorded an average of 27 miles per hour during the previous 24 hours, Sholapur 21 miles, and Poona 13 miles. Winds were light on the Malabar coast, but were blowing freshly at Bombay and Ratnagiri from north-east and east.

Moderate rain had fallen over a large part of the Peninsula during the previous 24 hours.

The character of the depression in the Arabian Sea is shown by the observations taken on board ships in the Arabian Sea. The following gives a summary of the noon observations on the 3rd:—

Vessel.	Position at Noon.		Barometer.		Approximate variation from normal.	Wind.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.		Direction.	Force.	
	° ′	° ′						
Manora . .	Colombo		29·80	29·95	+.03	W.-S.-W.	...	Showery.
Avoca . .	10—47	60—58	...	...	...	S.-W.	...	Fresh south-westerly breeze; rough sea.
Baghdad . .	13—1	49—4	30·02	29·87	—.16	N.-N.-W.	...	Light head wind and clear weather.
Lalpoora . .	13—2	74—12	29·95	·85	— 07	E.	...	Light continuous rain at noon.
Berenice . .	13—8	47—28	...	...	...	...	...	Winds light and variable.
Idar . .	13—10	48—32	...	...	...	Calm	...	Light airs and clear.
Graham . .	13—21	49—9	·92	·85	—·14	W.	...	High north-easterly swell; clear weather; light and variable winds.
Canara . .	13—30	74—29	·90	·84	—·08	S. by W.	...	Dull, cloudy weather; moderate sea. Wind strong.
Nur Jahan .	13—32	74—18	·92	·84	—·08	S.-S.-W.	4	Cloudy; light south-south-westerly sea.
Dalhousie. .	13—58	50—58	·96	·82	—·21	W.-N.-W.	3 to 4	Long south-east swell (south-westerly winds in afternoon).
Columbus. .	14—05	64—52	·48	·86	—·11	N.-N.W.	...	Fine clear weather; smooth sea.
Maria . .	15—7	70—5	...	...	...	E.-N.-E.	...	Stormy, with rain.
Drumbarlie .	16—15	61—14	·90	·89	—·15	N.-E.	...	Light breeze and clear.
Inchborva .	16—40	62—4	·75	·90	—·15	E.	...	Moderate breeze; clear sea.
Serapis . .	16—47	63—1	30·04	·90	—·15	E.-N.-E.	2	Fine clear weather.
Clyde . .	17—08	61—48	29·99	·93	—·12	N.-E. by E.	4	Ditto.
Coconada. .	16 ?	74 ?	·78	·81	—·09	S.	...	Light breeze; dark, gloomy weather.
Busheer . .	Moored off Cross Island, Bombay.		·84	...	...	...	...	Moderate breeze and fine.

VESSEL.	POSITION AT NOON.		BAROMETER.		Approximate variation from normal.	WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.		Direction.	Force.	
Knight Errant .	17—58	68—13	...	...	...	N.	...	Moderate breeze and fine weather.
Castor . .	18—38	72—22	29·84	29·83	—·14	Variable	...	Light breeze and clear weather in morning (squally in evening).
Apollo . .	18—49	72—42	...	...	...	N.	...	Fine weather. Variable winds during afternoon.
Assyria . .	25—02	62—56	30·02	·97	—·17	N.-W.	...	Fine clear weather; light breeze.
Henzada . .	20—57	61—54	29·97	·97	—·13	N.	2	Light fair wind and fine clear weather.
Yesso . .	21—13	67—10	?	...	...	...	...	Smooth sea. Fine clear weather
Pachumba .	At Cutch Mandvi		·90	·90	...	N.-E.	..	Light breeze and fine.

The information of the weather in the Arabian Sea on this day is unfortunately very imperfect. The charted observations (Plate XXXVIII) show that there was a shallow depression between Long. 66° E. and the west or Bombay coast. Over the whole of the north of the Arabian Sea weather was fine and clear, with light to moderate north to north-east breezes. There was also a shallow depression area in about Lat. 14° N. Long. 52° E. No information except the logs of the *Avoca* and the *Columbus* is available for the intermediate area between this small depression and the larger depression off the west coast. Barometric observations are not recorded in the log of the *Avoca*, and the single reading taken on board the *Columbus* on this day cannot be accepted with certainty as indicating the pressure distribution between Long. 56°E. and Long. 68°E. in this intermediate area. It is hence not possible to establish that a trough of low pressure ran across the centre of the Arabian Sea, and connected these two low-pressure areas, the existence of which is proved by the observations. It appears, however, to be most probable, more especially when the distribution of pressure on the preceding and succeeding days is taken into consideration. In that case this trough would represent the intermediate belt between the areas of north-east winds and of south-west winds which had occupied the northern and southern portions of the Arabian Sea during the previous four or five days, and also be the continuation of the low-pressure area which had occupied the centre of the Arabian Sea on the 1st and 2nd. The low pressure area at the eastern extremity would, on the same supposition, represent the effect due to the westward transmission of the general disturbance across the Peninsula and Ghâts into the Arabian Sea and its absorption into the area of disturbance previously prevailing in the latter sea.

The *Castor*, *Apollo*, *Busheer*, *Coconada*, and *Nur Jahan* were all near the west coast during the day. The *Castor* and *Apollo* approaching Bombay had light variable breezes, with fine clear weather. The *Busheer*, which left Bombay for Goa about noon, had fine weather during the afternoon, but the weather became gloomy in the evening. The *Coconada* in Lat. 16° N. at noon had fine weather during the day, and squally, gloomy weather at night. The ***Nur Jahan***, 160 miles south of the *Cocoanda* at noon, had fine weather and light southerly winds during the greater part of the day with drizzling rain in the evening. Hence the observations of these vessels give no indication of cyclonic winds or weather in the neighbourhood of the west coast on this day. One vessel, the ***Maria***, had stormy weather in the morning, with thunder and lightning and squally weather in the afternoon; but no observations are given of the barometer or wind force, and it is hence not possible to ascertain the real character of the storm which this vessel is stated to have experienced. She was in Lat. 15° 7′ N. and Long. 70° 5′ E. at noon. It is probable that this squally or stormy weather was in no way different from what had been experienced in the trough of low pressure or intermediate belt during the previous week, and that, as already pointed out in page 224, it. was merely a succession of squalls produced by the general disturbed weather in the Arabian Sea, and not a cyclonic storm which passed over the vessel. This is confirmed by the weather experienced during the night of the 3rd by the ***Busheer*** on her voyage from Bombay. The sky was very dark and heavy-looking at midnight. At 2 A.M. of the 4th a storm passed over the vessel from east to north-east, with very heavy rain, continual vivid forked lightning, and heavy peals of thunder. At 2-30 A.M. the weather began to break southwards. At 4 A.M. weather was still gloomy, with much lightning to the north-west. The *Busheer* was in about Lat. 17½° N., and in the immediate neighbourhood of the coast when the storm passed over her. This storm was almost certainly nothing more than a severe thunder-storm or prolonged rain squall.

4th November.—The following table gives 8 A.M. observations at stations on and near the west coast of India :—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Cochin . .	29·929	+·020	—·012	E.	0	0	81·2	—5·5	73·7	—0·4	10	0·97	
Wellington .	24·253	+·012	—·001	Calm.	1	33	71·0	+3·9	55·5	—0·1	10	0·07	
Mangalore .	29·903	+·003	—·019	E.	3	100	84·3	—1·3	73·9	—0·4	5	0·42	Fine.
Mercara . .	26·272	+·114	?	S.	2	50	78·3	+3·0	63·7	+1·7	8	0·19	Showery.
Calicut . .	29·922	+·029	—·034	E.-N.-E.	10	?	82·3	?	73·5	?	7	0·57	Sea smooth.
Karwar . .	·856	+·013	—·036	S.-W.	?	?	86·7	+0·3	74·7	+2·4	4	—	Sea rough.
Belgaum .	·863	—·007	—·057	E.	13	108	84·2	+2·7	67·3	+2·3	10	—	Distant lightning.
Goa . .	·756?	?	+·008	N.-E.	?	?	93·0	?	77·0	?	2	—	Fine.
Ratnagiri .	·858	+·009	—·055	N.-E.	8	89	95·4	+4·3	77·9	+5·5	8	0·06	
Bombay . .	·848	—·011	—·061	E.	8	80	90·9	+2·9	81·0	+6·4	10	—	Distant lightning.
Poona . .	·921	+·008	—·055	E.-S.-E.	12	200	89·1	+2·6	71·4	+7·7	10	0·05	Showery.
Sholapur .	·935	+·018	—·026	E.-N.-E.	20	250	91·2	+4·4	71·5	+4·8	6	—	
Surat . .	·886	+·002	—·064	S.	?	?	97·2	+5·1	70·0	+4·0	10	—	
Malegaon .	·950	0	—·057	E.-S.-E.	5	125	91·9	+4·6	75·1	+14·8	10	—	
Rajkot . .	·891	-·026	—·083	E.	3	60	96·4	+3·3	69·8	+7·1	4	—	
Deesa . .	·948	—·007	—·060	E.	8	100	95·3	+3·0	66·8	+7·2	1	—	Fine.

The barometer was rising over the greater part of India at this time, but the changes during the previous 24 hours were small. The barometer had fallen locally in Sindh and at Bombay. The coast observations indicated the existence of a shallow depression off the west coast between Bombay and Karwar. The winds were blowing freshly on the Konkan coast and were from directions varying from east at Bombay to north-east at Goa and Ratnagiri, and hence did not indicate the existence of a regular and well-defined cyclonic circulation off that coast. Winds were light and irregular in Northern India. Temperature was highest at this time in the Bombay coast districts at Surat, Bombay, and Ratnagiri. Skies were clouded over the whole of India, except the Punjab, Sind, and Rajputana. Local showers fell during the previous 24 hours in Orissa, Madras, Malabar, and some parts of Hyderabad, but the amounts were generally small.

The meteorological conditions were normal over the greater part of India at this time. The only unusual feature was the depression in the Arabian Sea off the west coast, the character of which was very faintly shown by the coast observations.

The following gives the noon meteorological observations taken on board vessels in the Arabian Sea on this day:—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Lombardy	5— 8	82—26	29·55	29·93	+·01	W.	4 to 5	Cloudy; heavy squalls in the morning.
Avoca	8—19	58—0	...	...	...	S.-W.	4	Fresh breeze.
Patna	Off Tuticorin		30·05	·93	—·01	W.-N.-W.	4	Light variable winds; cloudy and fine weather.
Canara	Tellicherry.		·98	·90	0	S.-E.	...	Moderate breeze.
Nur Jahan	Ditto		·96	·90	0	S.	2	Passing clouds; gentle breeze.
Baghdad	Aden.		30·06	...	...	E.	2	Fine clear weather.
Dalhousie	13— 4	47—32	30·01	·89	—·13	S.-E.	2	Winds light and variable; sea smooth; moderate south-east swell.
Othello	13—23	49—24	·20	·90	—·13	N.-E.	...	Strong wind and heavy sea.
Graham	13—31	51—38	29·97	·90	—·13	N.-E.	...	Fresh wind and cloudy.
Idar	14— 2	52—29	...	...	...	N.-E.	...	Fine weather. Fresh breeze.
Columbus	14—44	66— 1	·43	·82	—·15	N.	...	Very squally weather, blowing excessively hard; heavy head sea.
Lalpoora	16— 8	73—16	·94	·85	—·07	S.-E.	...	Light winds; clear.
Busheer	16—50	73— 7	·86	·85	—·08	S.-S.-W.	...	Dull weather and gloomy; fresh breeze; winds variable in morning.
Castor	Bombay	Harbour	·87	·85	—·12	Variable	...	Light breeze and cloudy; squally in evening.
Knight Errant	17— 3	63—55	...	...	...	N.	...	Moderate breeze; fine clear weather.
Coconada	South of Ratnagiri.		29·82	·85	—·08	N.-E.	...	Light breeze; squally in evening.
Drumbarlie	17— 3	65—18	·85	·84	—·19	N.-W.	...	Fresh breeze, with head sea.
Inchborva	17—26	65—24	...	...	...	E.-N.-E.	..	Strong winds, with heavy sea.
Maria	17—30	70—42	...	...	...	E.	...	Squally.
Serapis	17—43	67—31	29·95	29·80	—·22	N.-E.	4	Light, passing clouds.

Vessel.	**Position at Noon.**		**Barometer.**			**Wind.**		**Weather.**
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° '	° '						
Apollo . .	18— 8	68—37	...	...	...	S.-E.	...	Moderate variable winds; overcast; cross swell from north-east and south-east.
Clyde . .	18—10	67—13	29·90	29·84	—·19	N.-E.	...	Moderate to fresh winds; unsettled weather and overcast.
Lawada . .	18—38	72—40	·86	·84	—·13	N.-E.	...	Light breeze and cloudy sky.
Husara . .	22—14	68—38	30·08	·88	—·18	E.	2 to 3	Moderate breeze; smooth sea; pleasant weather.
Pachumba .	22—30	70—30	29·88	·88	...	N.	..	Light wind and fine.
Purulia . .	24— 2	61—33	·97	·91	—·20	S.-E.	...	Fine clear weather.
Assyria . .	24—15	60—38	·99	·94	—·15	Calm	...	Smooth sea and fine weather.
Hensada . .	19— 8	59—42	·95	·90	—·15	N.	...	Light fair winds and fine clear weather.

The preceding extracts show that over the Arabian Sea to the north of Lat. 20° N. and west of Long. 60° E. weather was fine and skies generally clear, winds light to moderate and sea smooth. Between the 60th meridian and the Bombay or West India coast there was (as shown on the chart of the day) a large oval-shaped depression, whose greatest diameter ran east and west. We have now to determine the weather in this area. A large number of vessels were passing through it, the logs of which enable the character of the weather to be accurately gauged.

The following table gives the whole of the meteorological information contained in their logs:—

Vessel.	Hour.	**Position at Noon.**		Corrected barometer.	**Wind.**		**Weather.**
		Latitude, North.	Longitude, East.		Direction.	Force.	
		° '	° '				
Columbus . .	2 A.M. .	...	...	...	N.-N.-W.	...	Wind increasing.
	7 „ .	...	...	...	N.-N.-W.	...	Squally, with thunder and lightning.
	10 „ .	...	...	...	N.	...	Thick weather; strong gale.
	Noon .	14—44	66—1	29·82	N.-W.	...	
	1 A.M. .	...	...	...	...	...	Blowing excessively hard. Very squally.
	Mid. .	...	...	...	...	...	Weather unchanged.
Knight Errant .	4 A.M. .	...	...	...	N.	...	Moderate to fresh breeze.
	Noon .	17—3	63—55	...	N.	...	Fine clear weather.
	8 P.M. .	...	...	...	N.	...	Moderate breeze and fine.
Drumbarlie . .	4 A.M. .	...	...	...	N.-W.	...	Moderate breeze and fine.
	Noon .	17—3	65—18	·84	...	...	Fresh breeze with head sea.

VESSEL.	Hour.	POSITION AT NOON.		Corrected barometer.	WIND.		Weather.
		Latitude, North.	Longitude, East.		Direction.	Force.	
Inchborva	1 A.M.	...	...	...	E.-N.-E.	...	Fresh wind and clear.
	8 „	...	...	...	E.-N.-E.	...	Strong winds; overcast; rain-squalls.
	Noon	17—26	65—24	...	N.	...	Strong wind and clear.
	8 P.M.	...	...	...	N.-E.	...	Strong wind; squally with rain; heavy S. E. sea.
Maria	1 A.M.	...	...	...	E.	...	Squally.
	4 „	...	...	...	E.	...	Squally, with rain.
	Noon	17—30	70—42	...	E.-S.-E.	...	Ditto.
Serapis	1 A.M.	...	...	...	N.-E. by N.	3 to 4	Sea smooth; fine weather, with passing clouds.
	4 „	...	...	29·75	N.-E. by N.	3 to 4	Ditto.
	8 „	...	...	·79	N.-N.-E.	3 to 5	Ditto.
	Noon	17—43	67—31	·80	N.-E.	4	Passing clouds.
	4 P.M.	...	...	·73	E. by N.	3 to 5	Ditto and passing showers.
	8 „	...	...	·80	...	...	Fine weather, with passing clouds.
	Mid.	...	...	·81	E.-N.-E.	3 to 5	Thunder and lightning.
Apollo	1 A.M.	...	...	...	N.	...	Light winds. Heavy lightning to south-east.
	4 „	...	...	...	Variable	...	Ditto.
	8 „	...	...	...	Variable	...	Moderate variable winds; overcast.
	Noon	18—8	68—37	...	S.-E.	...	Similar weather.
	4 P.M.	...	...	...	Calm	...	Overcast. Heavy south swell.
	8 „	...	...	...	Variable	...	Ditto.
	Mid.	...	...	...	N.	...	Light wind and overcast.
Clyde	1 A.M.	...	...	...	N.	4 to 5	Moderate to fresh breeze; overcast.
	4 „	...	...	29·82	N.	4 to 5	Moderate to fresh breeze. Lightning to south.
	8 „	...	...	·84	N. by E.	5	Fresh monsoon.
	Noon	18—10	67—13	·84	N.-E.	...	Moderate to fresh winds; unsettled weather; overcast.
	4 P.M.	...	...	·77	E -S.-E.	3	Light winds; clear.
	8 „	...	...	·85	E.-N.-E.	...	Moderate breeze and overcast.
	Mid.	...	...	·85	E.	5	Much lightning to south.

A reference to the chart shows that the wind directions in the depression do not indicate regular convergence to a centre. This suggests that the area was probably one of diffused disturbance and of squally weather, and this is practically borne out by the observations. The worst weather during the day was experienced by the ship *Columbus* and the steamer *Maria*. The former, in Lat. 14° 44′ N. and Long. 66° 1′ E. at noon, had a strong to hard gale from 10 A.M. until the evening. Neither her barometer nor wind observations, which are brief, and not sufficiently definite to be of much value, indicate that she was near the centre of an advancing cyclonic storm. The *Maria*, 350 miles to the east-north-east, had squally weather during the whole of the morning, with east winds and in the afternoon east-south-east and variable winds with squalls. As in the previous case, the information is too brief and vague to be of value in determining the character of the depression. The *Apollo* and the *Serapis* were less than 150 miles to the north of the centre of the depression at noon and were advancing eastwards. The former had moderate variable winds in the morning, with a heavy cross sea from north-east, and south-east and light winds and calms in the afternoon. The *Serapis* had east to north-east winds of force varying from 3 to 5 during the day, and a smooth sea in the morning. The *Drumbarlie, Knight Errant, Inchborva,* and *Clyde* were at somewhat greater distances to the north and north-west of the centre of the depression, but not more than 220 miles. The *Clyde* had light to moderate north-east winds (force 3 to 5) throughout the day, with overcast skies. The *Inchborva* had strong east-north-east winds and a heavy cross sea during the day and squalls in the evening. The *Knight Errant* experienced fine clear weather and moderate northerly breezes and the *Drumbarlie* light to moderate breezes. Heavy lightning was seen to the south-east from all these vessels in the evening. Not a single vessel records in her log winds of force exceeding 5.

Hence, over a large part of the depression, although the weather was unsettled, the winds were comparatively feeble and irregular, and indicated that the disturbance was diffused and lacked concentration.

The logs of the vessels passing along the west coast show the same irregularity. The *Nur Jahan, Canara,* and *Lalpoora* had gentle breezes or light airs during the day off the Malabar coast. The *Busheer,* off the Konkan coast, had light variable breezes and fine weather during the morning and frequent rain-squalls in the evening. The *Lawada,* off Bombay, had light variable airs and fine weather until evening, when it became squally, with lightning.

The land and sea observations hence establish that there was a shallow depression extending from Long. 62° E. to the Bombay coast and from Lat. 12° N. to Lat. 20° N. The centre of this depression was in about Lat. 16° N. and Long. 68½° E. The winds over a large part of this area were light, variable, and irregular in direction. The weather was squally over a considerable portion of it, and one vessel in the south-west quadrant experienced a strong gale for some hours. These facts appear to indicate that the disturbance was diffused and irregular in character, and was probably not a cyclonic storm in the strict sense of the word, but a cyclonic disturbance in its initial stage.

5th November.—The following table gives 8 A.M. observations at stations on and near the west coast.

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Cochin . .	29·932	+·003	+·010	E.-S.-E.	0	0	87·2	+1·4	74·4	+0·1	0	0·08	
Wellington .	24·257	+·004	—·011	Calm.	1	33	70·0	+2·0	53·0	−1·8	2	—	Fine.
Mangalore .	29·920	+·017	+·003	E.	4	133	85·8	−1·0	74·4	+0·5	6	0·07	Sea high.
Mercara . .	26·178	—·094	?	S.	4	100	77·8	+2·2	60·7	−1·7	6	—	Fine.

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Calicut . .	29·935	+·013	−·005	N.-N.-E.	6	?	85·3	?	75·0	?	10	0·07	Fine.
Karwar . .	·897	+·041	−·027	N.-E.	?	?	86·2	+0·1	73·7	+0·9	3	0·64	
Belgaum .	·920	+·057	−·029	Calm.	11	92	83·7	+2·3	66·8	+1·0	10	0·07	
Goa . .	?	?	?	E.	?	?	91·0	?	75·0	?	9	1·16	Continuous rain.
Ratnagiri .	·884	+·026	−·029	E.-S.-E.	10	111	88·4	−0·5	73·9	+2·4	8	0·08	Distant lightning.
Bombay . .	·891	+·043	−·054	E.	8	80	89·4	+2·8	77·0	+2·2	9	0·26	Thunder-storm.
Poona . .	·949	+·028	−·031	E.	9	150	82·5	−2·4	69·9	+5·4	10	0·23	Showery.
Sholapur. .	·959	+·024	−·020	E.	12	150	91·7	+5·4	69·5	+3·2	10	2·21	Do.
Surat . .	·885	−·001	−·072	S.-W.	?	?	97·7	+7·5	73·0	+8·3	6	—	Fine.
Malegaon .	·972	+·022	−·043	E.-N.-E.	5	125	87·9	+1·8	70·2	+10·6	1	0·32	
Rajkot . .	·880	−·011	−·090	E.-S.-E.	3	60	96·9	+4·3	76·6	+15·7	9	—	
Deesa . .	·936	−·012	−·071	E.-S.-E.	16	200	95·8	+3·4	73·8	+15·6	6	—	Strong wind.

Pressure had decreased during the previous 24 hours in Sindh and Guzerat and Northern India and increased in the Peninsula. The changes were small in amount. Pressure was absolutely lowest at Rajkot. Hence the observations in the Indian land area appeared to indicate that the depression in the Arabian Sea was still in existence and was extending or advancing northwards. Winds were generally unchanged in direction. Rain had fallen over the greater part of the Peninsula during the previous 24 hours and large amounts were received at several stations. The more important rainfalls were Bellary 3·5 inches, Masulipatam 2·8 inches, and Vizagapatam 2·1 inches.

The following table gives the noon observations for the day taken on board vessels in the Arabian Sea :—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Avoca . . .	5—43	54—58	...	...	...	S.-W.	...	Sea smooth ; very light winds.
Lombardy . .	6—43	78—52	29·55	29·93	+·01	W.	3 to 4	Moderate wind and cloudy, with occasional showers.
Patna . . .	Off Tuticorin.		...	...	...	...	...	Calm and fine clear weather.
Nur Jahan . .	Cochin.		...	...	...	S.	...	Light breeze.
Canara . . .	Cochin.		...	...	...	S.	...	Ditto.
Siam . . .	Off Aden.		30·06	29·96	...	N.-N.-E.	4	Moderate breeze and fine.
Berenice . . .	13—57	51—39	·12	·95	—·08	N.-E.	2	

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Othello	14—16	52—38	30·24	29·94	—·10	E.-N.-E.	...	Light wind and fine weather.
Graham	14—22	56—12	·00	·93	—·11	N.	...	Light wind and fine clear weather.
Imperator	14—35	52—50	29·83	·95	—·09	E.-N.-E.	1	Slight sea from east-north-east.
Columbus	14—48	66—18	·26	·64	—·33	N.-W.	...	Blowing very hard; heavy sea. Foggy weather; heavy squalls, with rain at 2 P.M., wind backed to westward, gale increased to a hurricane, barometer fell to 29·22, heavy squalls with intermittent calms in the afternoon.
Idar	15—25	57—20	...	...	...	N.	...	Light breeze and fine weather.
Lawada	15—50	73—20	30·00	29·87	—·05	S.-E.	...	High south-west swell; squally; fresh breeze.
Busheer	Goa.		...	...	...	S.	...	Fine, but cloudy.
Knight Errant	16—05	59—52	...	...	...	N.-N.-W.	...	Light breeze and fine clear weather; smooth sea.
Apollo	17—30	64—30	...	...	...	N.-N.-E.	...	Fresh breeze.
Drumbarlie	17—53	69— 4	29·70	29·69	—·31	E.	...	Strong winds, with high cross sea; squalls with heavy rain.
Inchborva	18— 3	68—24	·70	·74	—·28	E.-N.-E.	...	Strong winds, with heavy rain; much lightning, and south-east swell.
Pachumba	Off Bombay.		·88	·89	—·09	S.	...	Light airs and fine.
Lalpoora	Bombay.		·97	·90	—·10	Variable.	...	
Coconada	Bombay.		·86	·88	—·12	E.	...	Light breeze, with continuous rain.
Serapis	18—34	71—45	·99	·84	—·12	E.-S.-E.	3	Smooth sea.
Clyde	18—51	72—33	·95	·89	—·06	E.-S.-E to E.	2	Light breeze; fine.
Husara	19—50	71—24	30·08	·84	—·15	S.-E.	3	Light breeze; dull weather; passing clouds; moderate swell.
Assyria	Near Muskat.		·00	·95	...	S.-W.	...	Light breeze and fine weather.
Hensada	17—20	57—34	29·94	·94	—·12	W.-S.-W.	2	Gentle breeze and fine clear weather.
Maria	19— 0	71—42	...	...	...	E.-S.-E.	...	Variable winds, with squalls.

A reference to the chart of the day (Plate XL) shows that the depression covered the same portion of the Arabian Sea as on the 4th. It had, however, intensified considerably, and the pressure at the centre of the depression was now probably below 29·6″. The area of depression was, as hitherto, oval-shaped, but the largest diameter now ran north-east and south-west.

The logs of the three vessels, *viz.*, the *Columbus, Inchborva,* and *Drumbarlie,* which were in this area during the day, indicate the character of the disturbance on this day.

The information contained in their logs is given in full below:—

VESSEL.	Hour.	POSITION.		BAROMETER.	Wind.	Weather.
		Latitude, North.	Longitude, West.	Corrected.		
		° ′	° ′			
Columbus	1 A.M.	...	...	...	N.-W.	Blowing very hard; heavy sea; weather foggy, with lightning.
	8 ,,	...	...	...	N.-N.-E.	Heavy squall.
	9 ,,	...	...	...	N.	
	1 P.M.	...	...	...	N.-W.	Blowing excessively hard; strong heavy sea; weather foggy.
	2 ,,	...	...	...	N.-W.	Wind inclining to the westward.
	4 ,,	...	...	29·60	...	Gale increasing to a hurricane.
	5 to 6	...	...	...	...	Heavy squalls, with intermittent calms; high sea.
Drumbarlie	1 A.M.	...	...	...	N.-E.	Heavy rain; light breeze.
	4 ,,	...	...	...	N.-E.	Moderate and cloudy.
	8 ,,	...	...	...	E.	Ditto.
	Noon	17—53	69—4	29·69	E.	Strong wind. High cross sea; squalls, with heavy rain.
Inchborva	1 A.M.	...	...	...	E.-N.-E.	Strong winds, with terrific squalls, lightning, and heavy cross sea.
	8 ,,	...	...	...	E.-N.-E.	Ditto.
	10 ,,	...	...	...	E.-N.-E.	Hard squalls, with heavy rain.
	Noon	18—3	68—24	29·74	E. by S.	Strong wind and heavy rain; very threatening. Much lightning.
	8 P.M.	...	...	...	...	Strong wind and cloudy.

The chart shows that the centre of the depression was in Lat. 15½ or 16° N., Long. 67½° or 68° E., or very nearly the same position as on the 4th. The *Columbus* was probably 100 miles to the south-west of this position at noon, at which hour it was blowing very hard from north-west. Her log states that at 4 P.M. the gale increased to a hurricane, and the barometer (corrected) fell to 29·60″. As it is, however, stated that heavy squalls with intervals of calm lasted from 5 to 6 P.M., it is evident she was not near the centre, and it would appear that the estimate of the force of the north-west winds indicated by the use of the word "hurricane" is exaggerated. The *Inchborva*, at a distance of about 180 miles to the north of the centre at noon, had strong winds with terrific squalls from east during the morning. The weather improved slightly after 4 P.M. The *Drumbarlie* was 200 miles to the north-east of the centre of the depression at noon, and advancing eastward to Bombay. She had winds varying in force from light breezes to strong winds as the day advanced, although she was increasing her distance from the centre of the depression. This was most probably not due to difference of the strength of the winds in different quadrants, but to the increasing intensity of the storm.

These observations hence show that the depression was intensifying and developing into a severe cyclonic storm. It was evidently in the initial stage as t was stationary, and the weather was improving in the outer portion of the de-ression (and more especially at the west coast stations, including Bombay, atnagiri, and Karwar) whilst the storm itself was concentrating. The weather vas hence fine, with light winds along the west coast, and the indications of the torm shown by the observations of the coast stations were even feebler than on he previous day. The depression, in fact, appeared to be filling up and the veather to be improving, whereas in fact the favourable change in the weather vas due to the growth and concentration of the storm.

Weather was fine over the whole of the north and west of the Arabian Sea, s is proved by the remarks in the logs of the *Avoca*, *Othello*, *Graham*, *Assyria*, nd other steamers.

6th November.—The following table gives 8 A.M. observations of selected tations on and near the west coast:—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Cochin . .	29·934	+·002	+·015	E.	0	0	88·2	+1·8	75·2	+1·0	0	0·17	
Wellington .	24·253	—·004	—·012	Calm	1	33	70·5	+2·5	47·0	—7·7	2	—	Fine.
Mangalore .	29·931	+·011	—·006	E.-S.-E.	3	100	86·3	+0·1	74·4	—0·2	1	—	Sea falling.
Mercara . .	26·172	—·006	?	S.	2	50	78·3	+2·8	60·7	—1·8	4	—	Fine.
Calicut . .	29·934	—·001	—·019	S.-E.	6	?	86·3	?	74·0	?	2	0·08	Sea smooth.
Karwar . .	·902	+·005	—·013	S.-W.	?	?	87·8	+2·6	75·2	+2·4	4	—	Sea high.
Belgaum . .	·928	+·008	—·036	S.-S.-E.	7	58	82·7	+2·7	62·4	—0·9	1	0·04	Fine.
Goa . .	·919	?	+·003	S.-E.	?	?	88·0	?	75·0	?	9	—	
Ratnagiri .	·910	+·026	—·018	E.-S.-E.	9	100	87·9	—1·3	73·9	+2·0	1	—	Fine.
Bombay . .	·908	+·017	—·035	E.-N.-E.	9	90	88·9	+2·2	77·0	+3·0	3	0·18	Distant lightning.
Poona . .	·947	—·002	—·044	E.-S.-E.	8	133	85·0	+0·3	69·4	+5·9	3	—	Fine.
Sholapur .	·955	—·004	—·034	E.-N.-E.	12	150	81·7	—4·7	68·0	+3·6	6	—	Do.
Surat . .	·917	+·032	—·056	S.-W.	?	?	96·7	+6·7	72·0	+7·9	6	—	Do.
Malegaon .	·956	—·016	—·044	N.-E.	3	75	82·9	—1·6	70·2	+9·7	6	—	Do.
Rajkot . .	·907	+·027	—·077	E.	5	100	94·9	+2·7	71·8	+11·2	4	—	
Deesa . .	·947	+·011	—·045	E.	16	200	93·3	+0·8	70·8	+12·9	5	—	Strong wind.

The barometer was very steady over India at this time. It fell slightly during the previous 24 hours over the whole of India, except in Sindh and Rajputana. Pressure was, as it had been for some days previously, lowest off the west coast, but the depression in the Arabian Sea, judged by the coast observations only, appeared to be slowly filling up. The highest temperatures in India were recorded on this day at Surat, Rajkot, and Deesa. Rain continued to fall in scattered showers in the Peninsula and Orissa. Some light local showers were also received in the west coast districts, but weather was generally reported to be fine, with feeble winds and lightly clouded skies.

The following gives the noon observations of the 6th on board vessels in the Arabian Sea:—

Vessel.	Position at Noon.		Barometer.			Wind.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Canara	8—35	78—15	...	...	...	...	...	Moderate winds; smooth sea.
Nur Jahan	Near Allepy		...	...	...	S.	1 to 2	Light airs.
Patna	9—01	76—26	30·08	29·95	+·05	Variable	...	Light variable winds and fine clear weather.
Lombardy	9—13	76—09	29·56	·94	+·02	N.-N.-W.	2 to 3	Light winds and fine.
Lawada	13—09	74—31	30·04	·91	0	S.-E.	...	Fresh breeze, with cloudy sky; moderate west swell.
Siam	13—16	47—37	·05	·95	—·08	N.-E.	...	Moderate wind and fine.
Arcadia	13—24	48—30	·06	·95	—·08	E.	2	Light head wind and fine.
Othello	15—04	56—21	·17	·90	—·14	E.-N.-E.	...	Light wind and fine weather.
Knight Errant	15—05	55—47	...	...	...	N.-W.	..	Light breeze and fine clear weather.
Columbus	15—14	67—23	29·30	·68	—·28	W.-S.-W.	...	Thick clouds; moderate gale and sea, with intermittent squalls.
Graham	15—25	59—18	·98	·91	—·13	N.-E.	...	Fine clear weather.
Apollo	15—54	56—42	·98	·91	...	Northerly	...	Moderate breeze and fine weather.
Idar	16—28	62—03	...	...	...	N.	...	Brisk breeze and fine weather.
Inchborva	18—39	71—41	·75	·79	—·27	Variable	...	Strong winds and cloudy, with heavy rain.
Arabia	21—09	69—53	30·09	·89	—·14	N.-W.	...	Cloudy.
Assyria	Near Jask.		·04	·99	...	N.-W.	...	Light breeze and fine weather.
Hensada	15—34	54—2	29·94	·94	—·11	W. & N.	...	Gentle breeze and fine clear weather.
Imperator	15—53	58—9	29·73	·90	—·15	N.-E.	1	Heavy sea from east-north-east.
Berenice	14—52	55—58	...	...	...	N.-E.	1	Light swell.
Drumbarlie	Off Bombay.		...	...	...	...	...	Fine clear weather.

The chart of the day (Plate XLI) shows that the depression covered the same portion of the Arabian Sea as on the previous day and was oval-shaped, with its largest diameter running north-east and south-west. The meteorological information respecting the storm area on this day is very scanty, as most of the vessels which were passing through the northern quadrant on the previous day had now reached Bombay. There was only one vessel, *viz.*, the ship *Columbus*, which was in the storm area during the day. She was proceeding in a north-easterly direction from the Seychelles to Bombay, and as the depression was almost stationary she was advancing across the storm area in the direction of its longest diameter. She had the wind from north-west in the morning. Her position at noon is not given, but was probably in about Lat. 15½° N. and Long. 68° E. The wind shifted to west at 7 A.M., to west-south-west at 10 A.M., and to south at 8 P.M. It blew a moderate gale with frequent squalls during the greater part of the day.

This information is imperfect, but it appears to show that the storm had not developed any further during the previous 24 hours and had remained practically stationary in position. Hence the most probable explanation is that the disturbance was still a cyclonic storm in its initial or incipient stage. The logs of the

Lombardy Lawada, Nur Jahan, and *Inchborva* establish that the weather along the west coast from Bombay to Cochin was fine, with light to moderate breezes. The *Inchborva*, when approaching Bombay in the afternoon, had variable winds, with occasional heavy rain-showers. Over the north and west of the Arabian Sea to the north of Lat. 20° N. and west of Long. 60° E. the weather was fine and clear, with light winds and a smooth sea.

Hence the evidence appears to establish that the disturbance covered a smaller area in the Arabian Sea than on the previous day, that it was unchanged in character, and had not intensified or developed further. It was hence at this time a stationary disturbance or a cyclonic storm in the initial stage. The centre of the depression was, as on the 4th and 5th, in Lat. 15½ or 16° N. and Long. 68 or 68½° E.

November 7th.—The following gives 8 A.M. observations at stations on and near the west coast:—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.						
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.	Cloud proportion.	Rainfall in past 24 hours.	Weather.
Cochin . .	29·930	—·004	—·001	S.-S.-E.	0	0	88·2	+2·6	74·7	+0·1	0	—	
Wellington .	24·261	+·008	—·006	Calm.	1	33	71·5	+4·6	54·0	—0·8	7	0·01	Showery.
Mangalore .	29·935	+·004	—·006	E.	4	133	86·8	0	74·9	+0·3	0	—	
Mercara . .	26·179	+·007	?	S.	2	50	76·8	+2·4	62·2	—1·2	5	0·04	Fine.
Calicut . .	29·929	—·005	—·024	E.-N.-E.	7	?	85·8	?	73·5	?	0	—	
Karwar . .	·901	—·001	—·006	S.-E.	?	?	87·8	+1·9	73·3	+2·1	3	0·48	Sea high.
Belgaum. .	·917	—·011	—·037	S.-S.-E.	7	58	83·2	+2·0	64·4	+1·7	4	—	Distant lightning.
Goa. . .	·921	+·002	+·007	E.	?	?	86·0	?	75·0	?	0	0·14	
Ratnagiri .	·910	0	—·021	E.-S.-E.	11	122	89·9	+0·3	72·9	+2·2	10	0·31	Sea high.
Bombay . .	·926	+·018	—·052	E.-S.-E.	10	100	88·9	+2·6	75·0	+1·2	7	0·33	Distant lightning.
Poona . .	·939	—·008	—·062	Calm.	6	100	86·0	+1·9	68·9	+6·5	6	0·76	Fine.
Sholapur .	·948	—·007	—·047	E.-S.-E.	10	125	85·2	—1·0	68·5	+5·1	4	—	Do.
Surat . .	·936	+·019	—·046	S.-W.	?	?	94·2	+3·3	73·0	+7·4	8	—	
Malegaon .	·976	+·020	—·053	N.-N.-E.	4	100	86·9	+1·7	72·1	+12·1	10	—	
Rajkot . .	·931	+·024	—·054	E.	7	140	94·4	+2·8	71·8	+11·2	3	—	
Deesa . .	·995	+·048	—·033	E.-N.-E.	11	138	94·3	+2·5	61·8	+3·0	7	—	Fine.

The barometer was very steady over the whole of India at this time. The changes of the preceding 24 hours were everywhere very small in amount and of no importance. The barometer continued to rise in Sind and the observations of the west coast stations appeared to indicate that the depression, which had been in existence in the Arabian Sea during the previous four days had either filled up or passed away westwards. Weather was fine with light winds in Northern and Central India. Some light local showers continued to be received in Southern India and the west coast districts, but the amounts were now very small. The following table contains the noon observations of the 7th taken on board vessels in the Arabian Sea:—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Taif	4— 4	66—36	31·32	29·94	...	...	...	Light breeze and fine.
Canara	7—26	79—26	29·96	·90	—·01	S.-W.	...	Clear weather.
Nur Jahan	Tuticorin.		...	...	...	N.-W.	1	Light airs and fine.
Lawada	10—11	75—45	·93	·93	+·01	S.-E.	1 to 2	Fine weather.
Lombardy	12—55	74—37	·52	·90	—·02	E.-S.-E.	2 to 3	Light wind and fine.
Siam	14— 2	52— 0	30·10	·90	—·13	Calm	...	Fine weather.
Knight Errant	14—10	5—25	...	...	...	Variable	...	Light airs and fine.
Hensada	14—18	50—24	29·94	·89	—·14	Calm	...	Ditto.
Columbus	15—39	68—28	29·40	·78	—·18	S.-S.-E.	3	Heavy sea.
Apollo	15—54	56—41	...	...	...	N.	1 to 2	Fine weather.
Othello	15—55	59—52	30·12	·89	—·16	N.-N.-E.	3	Ditto.
Graham	16— 6	62—52	29·86	·79	—·23	N.	3	Cloudy weather; confused sea.
Idar	17—31	66— 2	·65	·78	—·26	N.-N-.E.	...	Fresh gale.
Busheer	Near Goa		...	...	...	...	...	Moderate breeze and fine.
Purulia	Near Kurrachee.		·96	·94	—·18	S.	...	Fine clear weather.
Assyria	Abbas Bunder.		30·04	·99	...	N.-W.	...	Ditto.
Berenice	15—51	60—19	...	...	...	N.-N.-E.	3	
Imperator	17— 0	63—34	29·75	·79?	—·24	N.-E.	3	Agitated sea.
Arabia	Kurrachee		30·10	·94	—·18	W.	...	Moderate breeze.

The chart of the day and the observations show that the weather conditions were unchanged in the north and west of the Arabian Sea, where weather was fine and clear with very light winds. Large and important changes had on the other hand occurred in the eastern half of the Arabian Sea. The depression in that area extended further to the westward, and was as on the two previous days oval-shaped, but the largest diameter ran east and west. The winds in the storm or depression area were cyclonic in direction, and the centre of the circulation at noon was in about Lat. 16° N. and Long. 67½° E. The centre of the depression had hence apparently moved a little distance westwards during the previous 24 hours. Whether this was due to motion of an actual centre or to extension of the storm area to the west and north which accompanied the development of the disturbance and incipient cyclone into a small but intense cyclonic storm, cannot be ascertained from the observations. The latter, however, appears to be more probable. Three vessels were in the storm area during the day. The following gives all the meteorological information contained in their logs:—

VESSEL.	Hour.	POSITION AT NOON.		BAROMETER.		WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Direction.	Force.	
		° ′	° ′					
Idar	1 A.M.	...	...	...	...	N.-N.-E.	...	Moderate gale.
	5 „	...	...	...	...	...	...	Very hard squalls.
	8 „	...	...	...	...	...	...	Fresh gale with very confused and high sea.
	Noon	17—31	66— 2	29·65	29·78	N.-N.-E.	...	Fresh gale.
	4 P.M.	...	...	...	...	...	...	Hard gale with very dangerous sea.
	8 „	...	...	·45	·58	N.-E. by N.	...	Hard gale with hard squalls.
	Mid.	...	...	·30	·43	...	...	Lightning to north-east.
Columbus	4 A.M.	...	...	...	...	S.-S.-E.	...	Fresh breeze; very high sea.
	Noon	15—39	68—28	·40	·78	S.-S.-E.	...	Ditto ditto.
	4 P.M.	...	...	...	...	S.-E.	...	Strong breeze and heavy sea.
Graham	4 A.M.	...	...	·90	·83	N.	Fresh	Fresh wind.
	Noon	16—6	62—52	·86	·79	N.	...	Confused sea.
	8 P.M.	...	...	·90	·83	N.	...	Clear, high easterly sea.

The *Idar* was to the north-north-west of the storm centre in the morning and advancing eastwards to Bombay. She had stormy weather throughout the day. Her barometer fell rapidly in the afternoon and at midnight stood at 29·43″ (corrected). At that time she had a hard gale with hard squalls and a dangerous sea. This large fall of the barometer not only showed that the depression was intensifying, but also that it was now beginning to move northwards. The wind slowly veered from north-north-east to north-east by north, probably in part due to the easterly motion of the vessel across the cyclonic storm area. Her position at midnight was approximately in Lat. 18¼° N. and Long. 66¾° or 67½° E. The centre of the storm was at that hour probably about 20 or 30 miles south, or in Lat. 17¾° N. and Long. 67° or 67¼° E. The *Columbus*, 150 miles to the south-east of the centre at noon, had fresh south-south-east winds, and the *Graham*, 300 miles to the west-north-west, had fresh to strong northerly winds with a high confused easterly sea.

The *Lombardy*, *Lawada*, *Canara*, and *Busheer* had fine clear weather with light breezes during the day off the Malabar and Konkan coasts. Winds were also light and weather fine over the whole of the west and north-west of the Arabian Sea.

November 8th.—The following gives 8 A.M. observations at selected stations :—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Ratnagiri .	29·909	−·001	−·020	E.-S.-E.	8	89	88·4	−1·2	73·9	+3·4	0	0·06	Fine.
Belgaum .	·931	+·014	−·031	Calm	6	50	81·7	−0·5	65·3	+2·2	8	—	Do.
Poona . .	·934	−·005	−·064	E.	6	100	86·0	+1·9	68·9	+5·9	5	0·05	Do.
Bombay .	·904	−·022	−·059	E.-S.-E.	9	90	85·9	−1·2	77·0	+2·5	9	0·10	Distant lightning.
Malegaon .	·968	+·008	−·067	E.	5	125	85·9	0	71·7	+12·0	3	—	Fine.
Akola . .	·966	+·017	−·051	N.-E.	4	133	87·5	+0·7	68·8	+7·5	8	0·10	Do.
Indore . .	30·024	+·028	−·030	E.-N.-E.	4	200	84·1	+2·1	61·6	+4·0	9	—	
Surat . .	29·918	−·018	−·076	S.-W.	?	?	96·2	+5·7	68·5	+3·5	4	—	Fine.
Rajkot . .	·910	−·021	−·095	E.	10	200	91·9	+0·3	74·7	+13·9	8	—	Do.
Deesa . .	·994	−·001	−·046	E.	10	125	91·3	−1·1	61·3	+3·7	5	—	Do.
Neemuch .	30·056	−·016	+·016	E.-N.-E.	3	38	84·4	−0·2	54·8	−1·9	3	—	Do.
Kurrachee .	29·963	+·007	−·069	N.-N.-E.	11	138	94·1	+5·5	67·4	+4·4	0	—	Dust haze.
Mount Abu .	26·125	−·005	−·039	E.-N.-E.	7	175	73·1	−2·2	59·9	+1·9	6	—	Fine.
Bhúj . .	29·943	−·025	−·070	E.	11	220	91·0	+0·3	69·9	+4·5	6	—	Strong wind.

The pressure changes of the preceding 24 hours in the Indian land area were everywhere small in amount and left the pressure distribution over India practically unchanged. The barometer was beginning to fall in Guzerat in front of the advancing storm, but the fall was as yet very small. Pressure was still below the normal in North-Western and Western India, indicating that the depression in the Arabian Sea had not yet filled up. The deficiency was slightly greater in Cutch and Kattiawar than elsewhere. The variations from the normal were however too small to indicate, except as a slight probability, that a cyclone storm was in existence off the Kattiawar coast and approaching it.

Winds continued to blow from east (the normal direction in November) at Bhúj and Rajkot, but were strengthening and were already double of their mean November force. Skies were more or less clouded in all districts except Upper India, and light local showers continued to be received in the coast district from False Point to Bombay. Weather was reported to be fine along the whole of the west coast, and the only indications afforded by the coast observations of the approach of a storm to the Kattiawar coast were—

1st.—The persistent depression off the west coast as indicated by the continued deficiency of pressure at the coast stations. Although the observations showed the existence of a depression off the Kattiawar coast, they gave no indication of the character or intensity of the approaching storm.

2nd.—The greater deficiency of pressure at Bhúj, Rajkot, Surat, and Deesa than at other stations in North-Western India. This line, or trough of deficient pressure, coincided approximately with the line of advances of the storm on the 9th.

The 4 P.M. observations at the same stations are given in the following table :—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Ratnagiri	29·840	+·027	+·008	S.-W.	19	211	3	
Belgaum	·864	+·024	—·010	W.-S.-W.	15	125	6	
Poona	·877	+·034	—·018	S.-E.	11	183	10	
Bombay	·837	—·018	—·029	S.	13	130	10	
Malegaon	·811	—·012	—·073	N.	6	150	10	
Akola	·815	—·006	—·048	E.	5	166	5	
Indore	·884	+·021	—·023	N.-N..E.	3	150	9	
Surat	·799	—·039	—·074	S.-W.	?	?	9	
Rajkot	·799	—·043	—·096	E.-N.-E.	13	260	9	
Deesa	·844	—·017	—·052	S.-E.	14	175	6	
Neemuch	·918	+·007	+·019	E.-N.-E.	8	100	7	
Kurrachee	·853	—·022	—·079	E.-S.-E.	18	225	0	
Mount Abu	26·057	—·007	—·035	E.-S.-E.	7	175	9	
Bhúj	29·812	—·055	—·089	E.	23	460	9	Strong wind.

The barometric observations show that the Kattiawar coast was, at 4 P.M., outside the storm area. Pressure was below the normal at Rajkot, Bhúj, Surat, and Deesa by almost exactly the same amounts as at 8 A.M., and hence afforded no more certain indication of the approach of a severe cyclonic storm than the 8 A.M. observations did. Skies had, however, clouded over and were now overcast and winds were increasing steadily in force. From the brief accounts of the storm, as experienced at the Kattiawar ports, it appears that the weather was very fine in the morning, and that it was not until about 4 P.M. that it changed and became threatening. Hence at 4 P.M. the indications of the approaching storm were slight and doubtful, and practically identical with those afforded by the 8 A.M. observations.

The following gives the noon observations of the 8th taken on board ships in the Arabian Sea :—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Lawada .	7—31	77—43	29·94	29·94	...	S.-W.	...	Light breeze. Smooth sea.
Siam . .	15— 4	56—39	30·06	·87?	...	N.-N.-E.	3	Ditto and fine.
Apollo . .	15—26	52—43	·00	·91	...	N.	...	Ditto ditto.
Berenice .	16—41	64—20	·00	·83	—·20	N.-N.-E.	3	
Lombardy .	16—26	73—10	29·52	·90	—·02	S.-S.-E.	2 to 3	Light wind and cloudy.
Arcadia .	16—36	60—46	·97	·85	—·21	E.-N-E.	4	Moderate and fine.
Othello .	16—38	63—2	30·18	·83	—·21	N.-W.	...	Light wind ; overcast. Heavy sea.
Graham .	16—44	65—53	29·90	·83	—·19	N.-W.	...	Ditto ditto.

Vessel.	Position at noon.		Barometer.			Wind.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Loodiana .	17—15	72—54	29·95	29·92	—·01	S.-S.-E.	...	Overcast; showery.
Imperator .	17—40	65—59	·61	·81	—·23	N.-N.-W.	3	Heavy sea.
Busheer .	18—0	72—52	·90	·90	—·04	S.-E.	...	Light breeze and fine weather.
Idar . .	18—1	68—41	·26	·39	—·71	N.-W.	...	Cyclonic gale.
Columbus .	18—9	70—42	·44	·82	—·15	S.-E.	...	Fresh breeze.
Calder . .	Near Bombay		·90	·90	...	Variable	...	Moderate breeze.
H. Bolckow .	20—22	56—54	·96	·96	...	N.-N.-E.	...	Ditto
Pachumba .	Gulf of Cambay		...	...	...	S.-W. by S.	...	Light wind with passing clouds.
Purulia .	21—49	69—11	·86	·86	—·20	E.-S.-E.	...	Moderate breeze and cloudy; long southerly swell.
Coconada .	Off Ratnagiri		·84	·92	+·01	W.	...	Fresh breeze and squally weather.

The weather chart of the day (Plate XLIII) shows that the depression had advanced northwards. It had intensified during the previous night and was now a small but severe cyclonic storm. The centre at 8 A.M. was probably in Lat. 17¾° N. and Long. 68½° E. It is not possible to fix its position exactly, as the position of the only vessel which was near the centre during the day was not entered in the log and was probably not observed during the day.

The following gives the whole of the information in the logs of the vessels which were in, or passed through the storm area, during the day:—

Vessel.	Hour.	Position.		Barometer.		Wind.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Direction.	Force.	
		° ′	° ′					
Graham .	1 A.M.	...	...	...	...	N.-W.	...	Moderate wind and high head sea.
	4 „	...	...	29·88	29·81	N.-W.	...	Weather unchanged.
	8 „	...	...	·88	·81	N. W.	...	Light wind with rain at times.
	Noon	16—44	65—53	·90	·83	N.-W.	...	Light wind; high head sea.
	1 P.M.	...	...	...	...	W.	...	Light wind and overcast; heavy sea.
	4 „	...	...	·89	·82	W.	...	Ditto ditto.
	8 „	...	...	·90	·83	W.	...	Light wind; rising north sea.
	Mid.	...	...	·92	·85	W.	...	Light westerly airs; high north sea.
Imperator	1 A.M.	...	...	...	...	N.-E	4	
	7 „	...	...	...	...	N.-N.-W.	2	Heavy sea from east-north-east and north-north-west.
	Noon	17—40	66—59	·61	·81	...	...	

Vessel.	Hour.	Position.		Barometer.		Wind.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Direction.	Force.	
		° ′	° ′					
Idar	1 A.M.	...	...	...	...	N.-N.-E.	...	
	2 "	...	...	...	...	...	...	Hard gale, evidently cyclonic; sea very confused; squalls increasing in force; weather thick; clouds very low.
	4 "	...	...	29·25	29·38	...	...	
	7 "	...	...	·28	·41	...	...	Weather same.
	8 "	...	...	...	...	...	...	Very hard squalls and sea very high.
	10-30 "	...	...	...	...	...	...	Hard squalls; barometer fallen.
	Noon	18—1	68—41	·26	·39	...	...	Cyclonic gale.
	2 P.M.	...	...	...	...	N.-W.	...	Sky gloomy, wind shifting westerly.
	4 "	...	...	...	...	W.-N.-W.	...	Sky gloomy, barometer steady.
	6 "	...	...	...	...	...	...	Sea and wind decreasing fast, but hard squalls at intervals.
	8 "	...	...	·40	·53	...	...	Brisk squally breeze, sky overcast.
	10 "	...	...	...	...	S.-W.	...	Wind shifting to south-east with lightning to north and north-west.
	Mid.	...	...	...	...	...	...	Fresh breeze; sky overcast.
Columbus	1 A.M.	...	...	...	...	S.-E.	...	Cloudy weather, heavy sea.
	5 "	...	...	...	...	...	...	Strong breeze with rain.
	Noon	18—09	70—42	·44	·82	...	...	Same weather.
	1 P.M.	...	...	...	...	S.	...	Fresh breeze.
	Mid.	...	...	...	...	...	...	Same weather, cloudy with rain.

The only vessel which passed through the storm on this day was the S. S. *Idar.* She was proceeding to Bombay and was in the north-west quadrant in the morning and not more than 30 or 40 miles from the centre. Her log states that it was blowing a hard gale at midnight, and that the clouds were very dense and low and the sea confused and high. The storm advanced slowly northwards to the east of the vessel and the wind shifted slowly from north-north-east through north to north-west during the morning, and was blowing from north-west at 2 P.M. The barometer during this period remained at nearly the same height, varying between 29·38″ and 29·41″. If allowance be made for the daily oscillation, the barometer fell slightly from 4 A.M. until noon and after that hour commenced to rise. The *Idar* was hence involved for nearly 12 hours in the inner storm area and had very hard squalls and a cyclonic gale during nearly the whole of that period. During the afternoon, as the storm advanced northwards and the vessel advanced eastwards on her course, the weather improved rapidly and wind backed through west to south-west. At midnight it was blowing a fresh breeze with overcast skies.

The *Columbus* was about 150 miles east of the *Idar*, near the Bombay coast.

She had fresh to strong southerly breezes with rain throughout the day, and was hence quite in the outskirts of the storm.

The *Imperator* was at a somewhat less distance to the west of the centre, and experienced a heavy sea and moderate north-east winds (force 4) at midnight and light north-north-west winds (force 2) at 7 A.M. She was hence outside the storm area.

The *Graham* was about 200 miles to the west-south-west of the storm centre and had light winds throughout the whole day, although steering for Bombay. The only indication of the distant storm was the heavy northerly swell and sea which she encountered during the day.

These observations hence indicate clearly that although the storm was one of very considerable intensity and (probably) accompanied with hurricane winds near the centre, it was of comparatively small extent, so that at distances of 100 to 150 miles to the east and west of the centre, the winds were only of force 4.

9th November.—The following give the 8 A.M. observations at selected stations in West and North-West India:—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Ratnagiri	29·957	+·048	+·005	N.-E.	11	122	87·9	—3·1	76·4	+4·2	0	0·20	Showery.
Belgaum	·986	+·055	—·005	E.-S.-E.	9	75	83·7	+1·4	66·3	+3·0	10	—	Distant lightning.
Poona	·969	+·035	—·040	Calm	7	117	87·5	+1·6	69·4	+6·4	8	0·30	Showery.
Bombay	·939	+·035	—·037	S.-S.-E.	15	150	86·4	—1·1	76·0	+1·0	10	0·26	Do.
Malegaon	·979	+·011	—·057	S.-E.	4	100	88·4	+2·1	70·2	+9·6	10	0·18	
Akola	·984	+·018	—·017	N.-E.	4	133	90·9	+3·1	68·8	+8·5	6	—	Fine.
Indore	·996	—·028	—·028	E.-S.-E.	3	150	84·6	+1·4	64·6	+7·7	9	—	
Surat	·904	—·014	—·076	S.-W.	?	?	92·6	—0·1	73·0	+7·9	5	0·13	Fine.
Rajkot	·846	—·064	—·190	E.-N.-E.	7	140	90·4	—1·8	70·8	+10·4	9	1·40	
Deesa	·947	—·047	—·085	E.	12	150	93·3	+1·3	70·8	+13·0	10	0·02	
Neemuch	30·058	+·002	+·006	E.-N.-E.	5	63	86·4	+0·6	54·8	—1·8	10	—	
Kurrachee	29·905	—·058	—·006	N.-N.-E.	12	150	93·1	+3·9	68·9	+5·4	8	—	Dust-haze.
Mount Abu	26·120	—·005	—·071	E.	7	175	75·1	—0·4	62·9	+4·4	10	—	
Bhuj	29·849	—·094	—·167	E.	17	340	73·8	—17·2	60·1	—4·0	10	—	Strong wind
Jacobabad	·956	—·011	—·033	E.	2	100	99·0	+9·5	57·4	+4·8	2	—	Fine.
Hyderabad	·961	—·053	?	N.-E.	6	100	?	?	61·1	—2·4	10	—	
Ajmere	30·070	—·020	—·053	Calm.	1	100	83·7	—5·4	53·3	+2·5	6	—	Fine.

Pressure had increased slightly during the previous 24 hours over the whole of India except in Sindh, Kattiawar, and Guzerat, where the barometer was falling briskly. The land observations indicated that the low-pressure area and cyclonic storm in the Arabian Sea was in the immediate neighbourhood of the Kattiawar coast.

The following table gives the whole of the information in the logs of vessels which were near the Kattiawar coast on the morning of the 9th:—

VESSEL.	Hour.	POSITION AT NOON.		BAROMETER.		WIND.		Weather.
		Latitude, North.	Longitude, East.	Actual.	Corrected.	Direction.	Force.	
		° ′	° ′					
Purulia	2-30 A.M.	...	...	...	...	S.	...	Heavy squall.
	4 ,,	...	...	29·75	29·69	S.	...	Fresh gale, with heavy rain-squalls.
	8 ,,	...	...	·88	·82	S.	...	Moderate to fresh gale, with frequent heavy rain-squalls.
	Noon	19—48	71—49	·88	·82	S.	...	Gale moderating.
	1 P.M.	...	...	...	...	S.-S.-W.	...	
Calder	1 A.M.	...	...	·78	·78	S.-E. to E. ?	...	Increasing wind and sea.
	4 ,,	...	...	·74	·74	S. E. to E. ?	...	Heavy squalls and high sea.
	8 ,,	...	...	·78	·78	S. E. to E. ?	...	Moderate gale with high confused sea and heavy squalls.
	Noon	20—32	69—34	·78	·78	S.-E. to E. ?	...	Same weather.
	4 P.M.	...	...	·78	·78	S.-W.- to S. ?	Strong	Wind decreasing and weather improving.
	8. ,,	...	...	·80	·80	W.-S.-W. ?	...	Ditto.
	Mid.	...	...	·88	·88	N.-W ?	...	Fresh wind with passing heavy clouds.
Hampstead	4 A.M.	...	...	·21	...	S.	...	Strong wind with rain-squalls.
	8 ,,	...	...	·24	...	S.	...	Strong wind and heavy sea.
	Noon	20—21	70—36	...	...	...	...	
	2 P.M.	...	...	...	...	W.	...	Wind and sea moderating.
	4 ,,	...	...	·22	...	W.	...	Weather fine.
	6 ,,	...	...	...	...	N.-W.	...	
	8 ,,	...	...	·28	...	N.-W.	...	Fresh breeze and cloudy.
	Mid.	...	...	·33	...	N.	...	Fresh breeze and cloudy; moderate sea.
Pachumba	4 A.M.	...	...	·78	·78	S.-S.-E.	...	Moderate gale with hard squalls and heavy rain (sighted Verawal).
	8 ,,	...	...	·76	·76	S.-S.-E.	...	Strong gale with heavy squalls.
	9-20 ,,	...	...	·74	·74	S.-S.-E.	...	Squalls of cyclonic force; high cross sea.
	11 ,,	...	...	·76	·76	S. by W.	...	
	Noon	Off Verawal		·76	·76	...	...	Weather slightly moderating.
	1 P.M.	...	...	·74	·74	S.-S.-W.	...	Strong gale; high cross sea.
	2 ,,	...	...	·74	·74	S.-W.	...	
	3-40 ,,	...	...	·75	·75	S.-W.	...	
	4 ,,	...	...	·76	·76	S.-W. by W.	...	Strong moderating gale and high cross sea.
	5 ,,	...	...	...	...	W. by N.	...	
	7 ,,	...	...	...	...	N.-W.	...	
	8 ,,	...	...	...	...	W.	...	Fresh wind with sharp squalls; sea moderating.
	Mid.	...	...	...	...	N.-W.	...	Moderate sea.

Of these four vessels, the *Pachumba* was nearest to the storm centre during the early morning. She was proceeding to Kurrachee and was a few miles to the south-east of Verawal at 8 A.M. She was probably not more than 10 or 15 miles to the east of the storm-centre at that hour when she experienced a strong gale with heavy squalls. She continued to advance in a north-west direction at a rate of 10 knots, and at 9-20 A.M., when evidently very near to the centre, had squalls of cyclonic force from the south and a high and increasing cross sea. Although she was now not more than a few miles to the east or south-east of the centre, her barometer was almost stationary during this interval, and hence shows that the barometric depression at the centre was probably not very large in amount and also that the storm was of very small extent.

The *Hampstead* was also proceeding from Bombay to Kurrachee and passed round the storm area in the southern quadrant and was in about Lat. 20° N. and Long. 71° E. at 8 A.M., or 70 or 80 miles to the south-east of the centre. She had strong winds from the south during the morning and fresh breezes and a moderate sea in the afternoon.

The *Purulia* passed Verawal shortly before midnight and steamed at the rate of 8 knots to the south-east during the morning. She had a moderate to fresh gale with frequent heavy rain-squalls. Hence, although she was less than 80 miles from the centre from midnight until 8 A.M., her barometer gave very little indication of the existence and character of the storm.

The *Calder* was proceeding from Bombay to Kurrachee and crossed the south-west quadrant of the storm. She was probably about 40 or 50 miles south of the centre at 8 A.M., at which time she experienced a moderate gale with heavy squalls and a high confused sea. The observations of this vessel hence strongly confirm the inferences made from those taken on board the *Purulia,* and prove that the storm was of small extent and that the winds were not violent at a distance of 50 miles from the centre.

The extracts from the logs of these four vessels hence show fully the character of the storm at this time. They establish conclusively that it was of small extent and probably of moderate intensity. At distances of 40 miles from the centre, the wind blew a moderate gale, and the vessels named above passed through the storm without loss or damage of any kind.

The coasting steamer *Vaiturna* passed Mangrol about 9 P.M., when the storm centre was at least 80 or 100 miles to the south, and was then steaming direct for Bombay. What happened to her afterwards can only be inferred, as she disappeared and left not a single trace to show her fate. Apparently she was overwhelmed during the night by the heavy sea when crossing the Gulf of Cambay and sank suddenly with all on board.

The evidence given before the Court of Inquiry on the loss of the *Vaiturna* as to the weather on the Kattiawar coast is very conflicting.

The native agent at Porebandar of the line to which the coasting steamer *Vaiturna* belonged, describes the weather at that port on the 8th and 9th as follows: "The storm commenced about 4 P.M. of the 8th. It increased very much that night and blew very hard. The wind blew from a little south of east at night. At about 8 or 8-30 A.M. on the 9th, the wind changed its direction and began to blow from the north."

The native agent at Mangrol, a small port nearly midway between Porebandar and Verawal, stated that the storm there began at 4 P.M. of the 8th. The wind was from the *west* at that hour and increased in force as the night advanced. The wind changed to *south* at 1 A.M. of the 9th and blew very hard. Before that hour it was not blowing very hard. The gale was at its worst at 1 A.M., and it continued to blow from the south until 10 or 11 A.M.

The account of the agent at Porebandar fits in and harmonises with the observations furnished by the vessels off the Kattiawar coast, and shows that the storm crossed the coast east of Porebandar about 8-30 A.M. Some of the statements of the agent at Mangrol are evidently erroneous. It is impossible the wind could have been at west during the night when the storm was approaching. Probably, however, he made a mistake into which observers occasionally fall, *viz.*, that of stating the wind direction as that to which the air is going instead of that from which it is advancing. If this be correct, the actual change of wind would be from east to north at that station, and would hence establish that the storm centre also passed to the east of Mangrol. This would also explain the fact that the northerly winds did not increase much in strength during the early morning, and the other facts stated by the agent.

It would hence appear from a consideration of the whole data that the storm centre passed across the Kattiawar coast between Mangrol and Verawal, and probably nearly midway between them or at about 20 miles from either port at about 8 or 8-30 A.M. on the 9th. It advanced during the day through the centre of Kattiawar, giving a severe gale of wind and heavy rain to the greater part of that area, and more especially in those districts near the track of the centre. It has, however, not been possible to obtain exact data of the storm at this period.

The following table gives the noon observations taken on board ships in the Arabian Sea on the 9th :—

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Latitude, North.	Longitude, East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° '	° '						
Othello	17—15	66—19	30·15	29·92	—·10	N.-W.	...	Light wind.
Graham	17—52	69—21	·03	·96	—·04	S.-W.	Light	Clear weather; decreasing sea in the afternoon.
Arcadia	17—54	66—55	29·95	·83	—·20	N.	2	Fine clear weather.
Idar	18—52	71—34	·65	·78	—·18	S.-S.-W.	...	Weather clearing; sea smooth.
Purulia	19—48	71—49	·88	·82	—·15	S.	...	Gale moderating.
Calder	20—32	69—34	·78	·78	—·25	S.-E.	...	Moderate gale, with high confused sea and heavy squalls.
Hampstead	20—21	70—36	...	...	...	S.	...	Strong wind and heavy sea.
Pachumba	Off the Kattiawar Coast		·76	·76	...	S. by W.	...	Squalls of cyclonic force.
Comilla	30 miles north of Bombay.		30·02	·90	—·08	S.-E.	...	Fine clear weather.
Columbus	19—23	73—0	29·48	·86	—10	S.	...	Fine weather.

These observations show that at noon fine clear weather with light to moderate winds obtained over the whole of the Arabian Sea, except the immediate neighbourhood of the Kattiawar coast, where a south to south-east gale was blowing. The *Pachumba* off the West Kattiawar Coast reported squalls of cyclonic force at that hour.

The small extent of the storm is shown clearly by the fact that the *Idar* had already passed into smooth water as she approached the Bombay coast during the morning.

The 4 P.M. observations taken at stations in and near the storm area are given in the following table:—

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since 4 P.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Ratnagiri	29·850	+·010	+·011	S.-W.	15	167	1	
Belgaum	·870	—·004	—·010	S.-S.-W.	9	75	6	
Poona	·838	—·011	—·020	W.	11	183	8	
Bombay	·852	+·015	—·012	S.-S.-W.	15	150	10	Showery; strong wind.
Malegaon	·812	—·004	—·069	S.-E.	8	200	10	
Akola	·803	—·012	—·054	N.-E.	7	233	9	
Indore	·822	—·050	—·064	E.-S.-E.	7	350	9	
Surat	·805	+·006	—·058	S.-W.	?	?	8	
Rajkot	·767	—·042	—·036	S.-S.-W.	25	500	7	
Deesa	·854	—·009	—·055	E.	17	213	10	Strong wind.
Neemuch	·922	—·023	—·003	E.-N.-E.	11	138	10	
Kurrachee	·810	—·043	—·009	E.-N.-E.	16	200	3	
Mount Abu	26 015	—·042	—·071	E.-N.-E.	10	223	10	Strong wind.
Bhúj	29·778	—·046	—·128	E.-N.-E.	22	440	10	Ditto.
Jacobabad	·867	—·007	—·025	Calm.	3	150	2	
Ajmere	·020	—·014	—·066	S.-E.	6	600	10	

These observations indicate that the centre at 4 P.M. was between Rajkot and Bhúj and near Rajkot. The depression was much smaller in amount than at 8 A.M. Strong south-west winds blew across the Kattiawar coast and brought up very heavy rain during the day. Skies were beginning to clear at Rajkot and probably over the western half of Kattiawar. Cloud had extended rapidly eastwards, and skies were now overcast over nearly the whole of Rajputana and Central India, and weather unsettled, with strong easterly winds.

November 10th.—The following gives the 8 A.M. observations in Western and North-Western India:—

STATION.	BAROMETER.			WIND.			TEMPERATURE DURING PREVIOUS 24 HOURS.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A. M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Ratnagiri	29·955	—·002	+·022	E.	7	78	86·9	—4·0	74·9	+3·0	2	0·03	Fine.
Belgaum	·950	—·036	—·018	W.-N.-W.	8	67	83·7	+2·6	66·8	+3·2	8	—	Do.
Poona	·976	+·007	—·024	Calm	8	133	87·0	+0·8	66·9	+4·2	3	—	Do.
Bombay	·954	+·015	+·010	S.-S.-E.	13	130	85·4	—1·7	78·0	+3·2	7	0·03	Do.
Malegaon	·967	—·012	—·052	W.	5	125	84·9	—2·4	68·2	+8·0	5	—	Do.
Akola	·947	—·037	—·048	N.-E.	4	133	90·9	+2·8	73·2	+12·9	9	—	Distant lightning.
Indore	30·033	+·037	—·030	E.-S.-E.	6	300	85·6	+3·1	59·1	+4·0	9	0·11	Do.

Station.	Barometer.			Wind.			Temperature during previous 24 hours.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A. M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Surat	29·934	+·030	—·043	S.	?	?	88·1	—2·4	71·0	+6·2	8	0·09	Fine.
Rajkot	·928	+·082	—·071	W.-S.-W.	14	280	75·9	—15·4	64·9	+5·2	10	0·02	
Deesa	·924	—·023	—·092	E.-S.-E.	19	238	82·1	—9·8	64·8	+6·6	10	0·57	
Neemuch	30·044	—·014	—·009	E.-S.-E.	7	88	85·9	+0·3	58·8	+3·2	10	0·40	Drizzling.
Kurrachee	29·930	+·025	—·072	N.-N.-E.	9	113	93·1	+5·0	64·9	+2·9	0	—	Dust-haze.
Mount Abu	26·047	—·073	—·099	S.-E.	11	275	67·6	—7·2	57·9	—0·6	10	0·41	Showery.
Bhuj	29·950	+·101	—·043	N.	12	240	86·3	—4·3	69·5	+4·9	5	—	Cloudy.
Jacobabad	·923	—·033	—·057	E.	1	50	93·5	+4·4	53·5	+2·9	3	—	Fine.
Hyderabad	·928	—·033	—·044	N.-E.	4	67	90·2	+0·5	63·1	+1·5	0	—	
Ajmere	·986	—·085	—·084	S.-W.	4	400	80·2	—8·1	53·3	+2·8	8	—	Fine.

The chart of the day, Plate XLV, shows that the depression had advanced during the previous 24 hours in a north-east by east direction across Kattiawar. The centre at 8 A.M. was in Lat. 23¼° N. and Long. 71½° E. It had hence crossed the Girnar group of hills, the highest points of which are about 3,500 feet in elevation. The resistance offered by these hills to the rotatory air motion had already diminished the strength of the winds very greatly and the depression was rapidly filling up.

The observations given above indicate that the barometer at the centre was probably not lower than 29·80", and that the depression below the normal did not exceed two-tenths of an inch. The barometer was rising rapidly in Cutch and Kattiawar, but was falling briskly in West Rajputana and Central India. The depression was greatest at Deesa and Mount Abu, towards which the centre was advancing. The cyclonic circulation of the storm still extended over the whole of North-Western India (*i.e.*, over Central India Rajputana, Sindh, Cutch, and Kattiawar), and the adjacent sea area. Light to moderate rain had fallen in Cutch, Kattiawar, and South-West Rajputana, and had caused a very rapid reduction of the day temperature, greatest at Rajkot (15°), Deesa (10°), and Ajmere (8°).

The position and character of the storm at 4 P.M. are indicated by the following observations taken at that hour:—

Station.	Barometer.			Wind.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Bombay	29·870	+·018	+·017	W.-N.-W.	7	70	8	
Malegaon	·796	—·005	—·055	W.-S.-W.	10	250	4	
Akola	·774	—·025	—·075	N.-N.-W.	8	266	7	
Indore	·827	—·004	—·058	S.-S.-W.	4	200	9	
Surat	·836	+·032	—·023	S.-W.	?	?	0	
Rajkot	·875	+·102	—·019	N.-N.-W.	4	80	7	
Deesa	·862	+·010	—·030	S.-E.	4	50	10	
Neemuch	·912	—·033	—·023	E.-S.-E.	9	113	8	
Kurrachee	·836	+·026	—·073	W.-S.-W.	13	163	0	Strong wind.

STATION.	BAROMETER.			WIND.			Cloud proportion.	Weather.
	Actual, reduced to sea-level.	Change since previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.		
Mount Abu . . .	25·983	—·032	—·099	N.-E.	4	100	10	Overcast and showery.
Bhúj . . .	29·838	+·070	—·037	N.-N.-E.	9	180	0	
Jacobabad . . .	·810	—·058	—·075	E.	2	100	0	
Hyderabad . . .	·822	?	—·064	N.-W.	5	83	0	
Ajmere . . .	·866	—·053	—·094	S.-E.	9	...	6	

These observations show that the storm centre had not crossed the Mount Abu range of hills, which form an outlying portion of the Aravallis. They attain to an elevation of about 4,500 feet, and served apparently as a perfect barrier to the advance of the storm in the easterly direction.

The storm area was included between the stations of Bhúj, Rajkot, and Deesa. The changes of wind since 8 A.M. at these stations (at Bhúj from north to north-north-east, at Rajkot from west-south-west to north-north-west, and at Deesa from east-south-east to south-east) indicated that the storm was marching in a more northerly direction than on the previous day. It had hence probably been deflected on approaching the Mount Abu hills and was now marching slowly northwards and filling up. The cyclonic circulation was also much feebler and less regular than on the 9th, and was evidently breaking up.

Skies were overcast or heavily clouded in Kattiawar, Cutch, Rajputana, North Bombay, and Central India, but were clear in Sindh. Light to moderate rain continued to fall in Guzerat, South-West Rajputana, and the western districts of Central India.

The 8 A.M. observations taken on board vessels in the Arabian Sea are given in the following table. They call for no remark; as they show that weather was fine, winds light, and sea smooth over the whole of the north-east and east of the Arabian Sea.

VESSEL.	POSITION AT NOON.		BAROMETER.			WIND.		Weather.
	Lat., North.	Long., East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
	° ′	° ′						
Loodhiana	10—5	67—44	29·99	29·96	+·01	S.	...	Light airs; fine clear weather.
Siam .	16—57	65—11	30·11	·91	—·12	N.-N.-E.	3	Light breeze and fine.
Calder .	21—32	67—44	29·91	·91	—·21	N.-W.	...	Decreasing wind; weather improving.
Hampstead	22—41	67—24	·37	·92	—·2	N.	...	Light breeze and fine clear weather.
Comilla .	22—48	69—12	30·08	·96	+·15	S.-E.	...	Fine weather.
Pachumba .	Cutch Mandvi.		29·95	·95	—·16	N.	...	Light airs and fine.

November 11th.—The following gives 8 A.M. observations at stations in North-West India:—

Station.	Barometer.			Wind.			Temperature in past 24 hours.				Cloud proportion.	Rainfall in past 24 hours.	Weather.
	Actual, reduced to sea-level.	Change since 8 A.M. previous day.	Variation from normal.	Direction.	Velocity per hour.	Percentage ratio of actual to normal velocity.	Maximum.	Variation from normal.	Minimum.	Variation from normal.			
Poona . .	29·995	+·019	—·022	Calm.	7	117	86·0	+ 0·1	66·9	+ 3·0	5	—	Fine.
Bombay .	·977	+·023	—·002	E.-N.-E.	6	60	85·4	— 0·9	77·0	+ 2·1	3	—	Do.
Malegaon .	·990	+·023	—·035	W.	5	125	89·9	+ 2·5	67·3	+ 6·3	4	—	Do.
Akola . .	·970	+·023	—·055	N.-N.-E.	5	167	91·9	+ 4·4	70·7	+ 9·5	9	—	
Indore . .	·973	—·060	—·054	N.-N.-W.	3	150	84·1	+ 1·0	64·1	+ 7·3	2	—	Do.
Surat . .	·983	+·049	—·007	S.	?	?	91·6	+ 0·8	69·5	+ 3·8	4	—	Do.
Rajkot .	·959	+·031	—·018	Calm.	2	40	72·5	—19·9	63·9	+ 2·9	0	—	
Deesa . .	·985	+·061	—·038	S.-W.	6	75	74·1	—17·8	66·3	+ 7·0	10	0·45	
Neemuch .	30·013	—·031	—·045	S.-W.	4	50	84·9	— 1·6	63·7	+ 8·5	7	0·04	Showery.
Kurrachee .	29·927	—·003	—·085	W.	9	113	91·2	+ 2·3	73·8	+12·3	0	—	
Mount Abu .	26·078	+·031	—·076	N.-N.-W.	3	75	62·1	—12·7	57·9	— 1·1	3	0·20	Showery.
Bhuj . .	29·969	+·019	—·032	N.-W.	5	100	91·0	+ 0·4	66·0	+ 1·8	0	—	Fine.
Jacobabad .	·926	+·003	—·080	N.-W.	1	50	91·5	+ 3·6	55·0	+ 4·4	0	—	Clear.
Hyderabad .	·915	—·013	—·068	S.-W.	16	267	90·7	+ 1·8	66·5	+ 5·7	0	—	
Ajmere .	·996	+·011	—·093	S.-W.	4	400	79·1	— 7·8	65·7	+12·8	10	0·20	Distant lightning.

Pressure had increased in Guzerat, Sind, Khandeish, and West Rajputana—briskly at Deesa, and moderately elsewhere. The depression had continued to fill up and was now very shallow. It overlay West Rajputana and Sindh. The cyclonic circulation had broken up, and winds were light and irregular over the whole of North-Western India. Skies were clear in Sindh, Cutch, and Kattiawar and were lightly clouded in Rajputana and Central India. Some local showers of little importance had been received in Rajputana and Central India during the previous 24 hours.

The following 8 A.M. and 4 P.M. observations taken on board vessels in the Arabian Sea are given to show that fine weather, moderate breezes, and a smooth sea now obtained over the north-east and east of the Arabian Sea north of Lat. 18° N.:—

Vessel.		Position.		Barometer.			Wind.		Weather.
		Lat., North.	Long., East.	Actual.	Corrected.	Approximate variation from normal.	Direction.	Force.	
		° ′	° ′						
Siam .	8 A.M.	17—50	68—40	30·10	29·90	—·21	N.-E.	4	Moderate wind and fine.
Calder .		22—16	64—27	29·99	·99	—·14	W.	...	Moderate breeze and fair; sea smooth.
Pachumba		At Kurrachee		·95	·95	—·18	W.-N.-W.	...	Moderate wind and fair.
Comilla .		...	...	30·10	·90	...	N.-W.	...	
Comilla .	4 P.M.	Off Cutch		·10	·90	...	N.-W.	...	Moderate breeze.
Loodhiana		...	...	29·92	...	...	S.	..	Light breeze and fine.
Calder .		22—22	63—19	·92	·92	—·21	W.	4	Moderate breeze, with fair weather and smooth sea.
Siam . .		17—57	70—15	30·10	·90	—·20	N.-N.-E.	4	Moderate breeze and fine.

The depression filled up completely on the afternoon of this day, and fine clear weather again set in over North-Western India and Upper India on the 12th. The general disturbance, of which the two cyclonic storms in the Bay of Bengal and the Arabian Sea formed the most prominent features, hence lasted from the 26th and 27th October to the 11th of November, or upwards of a fortnight.

CHAPTER IV.

Concluding Remarks.

The present chapter deals with the more prominent and important phenomena of the three cyclones which have been described in the preceding pages.

The facts have been stated so far as possible without reference to any particular theory of cyclone generation and motion. In the case of the second and third storms, the knowledge of which depends chiefly upon the information supplied by vessels traversing the Bay of Bengal and Arabian Sea at the time, every effort has been used to utilize their observations as fully as possible. A portion of the information is doubtful and conflicting, and it was consequently necessary to discriminate between what was almost certainly correct, and what was doubtful or almost certainly wrong.

It is, however, much to be regretted that in the majority of these vessels the observations were not only scanty but affected by errors which it is hardly possible to eliminate. This is the more to be regretted as the absence of full and accurate information retards very considerably advance in our theoretical knowledge of these storms and the practical application of this knowledge for the benefit of sailors. Full and reliable information and observations respecting three or four storms in the Bay of Bengal and Arabian Sea would probably do far more to place on a certain basis our knowledge of the character of the air motion that constitutes a cyclonic storm, than the imperfect data which are at present available to meteorologists in the discussion of these storms.

I.—Discussion of the more important features of the first Storm.

Origin of the first Storm.—The data given in the preceding pages establish almost conclusively that the storm crossed Tenasserim, and hence probably advanced from the Gulf of Siam across the Malayan Peninsula. It is the first cyclonic storm of the Bay of Bengal on record which did not originate in that area but passed into it from another sea area.

Track of the Storm.—The following table gives the position of the storm centre and its average rate of motion at different periods during the existence of the storm :—

Date.	Hour.	Position of centre.			Distance passed over in previous interval.	Rate of motion in miles per hour during previous interval.
			Latitude, North.	Longitude, East.		
13th	8 A. M.	Probably east of Tavoy in Siam.	Tenasser	im Hills		
,,	4 P. M.	South-east of Moulmein.	15° 30'?	98° 30'?		

Date.	Hour.	POSITION OF CENTRE.			Distance passed over in previous interval.	Rate of motion in miles per hour during previous interval.
			Latitude, North.	Longitude, east.		
			° ′	° ′		
14th . .	8 A.M. .	Between Diamond Island and Bassein.	16 30	94 40	270?	17? miles.
„ . .	4 P.M. .	...	17 15	93 15	110	14 miles nearly.
15th . .	8 A.M. .	...	18 40	90 15	210	13 „
„ . .	Noon .	...	19 0	89 35	55	14 „ nearly.
16th . .	3 A.M. .	False Point . .	20 20	86 47	205	13⅔ „ „
„ . .	8 A.M. .	20 miles west of Cuttack.	20 35	85 45	73	15 „ „
„ . .	4 P.M. .	Near Sambalpur .	21 10	83 45	130	16¼ „
17th . .	8 A.M. .	East of Nagpur .	21 25	80 0	235	15 „ nearly.
„ . .	4 P.M. .	North-west of Nagpur.	21 25	79 0	65	8 „
18th . .	8 A.M. .	...	22 0	78 30	52	3¼ „
„ . .	4 P.M. .	North of Pachmarhi.	23 20	78 25	88	11 „
19th . .	8 A.M. .	Jhansi . .	25 25	78 15	150	9⅜ „
„ . .	4 P.M. .	Agra . .	26 40	77 50	120	15 „
20th . .	8 A.M. .	Meerut . .	29 30	77 30	160	10 „

The data show that the storm advanced with a probably nearly uniform velocity of 13½ miles across the Bay, and that its rate of motion increased slightly in its passage across Orissa and the eastern districts of the Central Provinces up to a maximum velocity of nearly 17 miles on the afternoon of the 16th. It advanced during this part of its motion in a nearly straight path or course through a distance of upwards of 1,300 miles from Tenasserim to Nagpur. Its westward motion was by some cause then arrested, and it recurved from west to north during the next 24 hours, during which its velocity averaged only 5 miles, and during the greater part of the time did not exceed 3 miles per hour. Its rate of motion increased rapidly when the recurvature was complete, and it moved northwards with nearly uniform velocity averaging 10 miles per hour until its disintegration at the foot of the Simla hills.

It hence furnishes a remarkable example of the diminution of velocity which accompanies recurvature, this diminution depending upon the amount of the recurvature.

The recurvature occurred when it had passed over the Orissa hills, and whilst it was in the comparatively open ground to the south of the Satpuras, including the Amraoti, Nagpur, Wardha, Chhindwara, and Betul districts of the Central Provinces and Berar. Cyclonic storms in India frequently recurve when approaching a line of hills towards which they are directly advancing. In the present instance the recurvature was due to other causes, and not to the obstructive and deflecting action of a line of hills. The causes of the recurvature are discussed in a future paragraph.

Character of the Cyclone.—The first indications of the existence of the storm in the Indian area were exhibited on the evening of the 12th. It passed over the Simla hills on the afternoon of the 20th, and was then a well-define storm and cyclonic circulation, although beginning to break up under the destructive action of the hills. It hence had an existence of at least eight days. It marched over the following hill ranges:—

1st—Tenasserim hills, averaging 4,000 feet in height where they were crossed by the storm.
2nd—Bassein hills, averaging about 1,500 feet in height.
3rd—Orissa hills, averaging about 3,000 feet in height.
4th—Satpura hills, averaging about 3,000 feet in height.
5th—Vindhya hills, averaging about 3,000 feet in height.

It recurved in the open country of the central and western districts of the Central Provinces. In no case was its direction of motion influenced to any appreciable extent by the resistance of the hills. A slight increase of velocity occurred for some hours after crossing the Orissa hills, but this was almost certainly not due to any action or effect of these hills. It was hence almost certainly a cyclonic storm of high elevation, the active portion of which (characterized by most rapid condensation and ascensional motion) was at an elevation of over 6,000 or 7000 feet, and perhaps even above 10,000 feet. This is further corroborated by the fact that the barometric changes and air movement were larger at the two hill stations of Pachmarhi and Simla, over which the storm passed, than at the neighbouring plain stations. It will be sufficient to illustrate these remarks by the barometric observations of the following stations:—

Hill station.	Neighbouring plain stations.
Pachmarhi	Nagpur. Jubbulpore. Hoshangabad.
Simla	Ludhiana.

The following table gives the daily barometric movements or changes at these six stations in each period of 24 hours ending at 8 A.M. during the storm from the 13th to the 20th:—

Station.		Change in the height of the barometer during the 24 hours ending at 8 A.M. of the								
		13th.	14th.	15th.	16th.	17th.	18th.	19th.	20th.	21st.
Hill station	Pachmarhi	—·007	—·052	—·026	—·016	—·183	—·089	+·221	+·196	+·121
Plain stations	Nagpur	—·026	—·023	—·027	—·056	—·173	+·024	+·226	+·169	+·038
	Hoshangabad	—·023	—·048	—·002	—·020	—·154	—·096	+·165	+·250	+·071
	Jubbulpore	—·033	—·030	—·009	—·021	—·132	—·019	+·102	+·128	+·137
Hill station	Simla	—·008	—·018	+·014	+·006	—·046	+·040	+·006	—·063	+·147
Plain station	Ludhiana	—·053	—·017	+·036	+·010	—·052	+·021	+·003	—·025	+·141

The first series of data for Pachmarhi and the adjacent plain stations may be summarized as follows :—

STATION.	Total fall of barometer from 13th to 17th or 18th.	Total rise of barometer from 17th or 18th to 20th.	Ratio of rise in 3 days to fall in 6 days.
Pachmarhi	—·373	+·538	1·47
Nagpur	—·295	+·457	1·54
Hoshangabad	—·343	+·488	1·45
Jubbulpore	—·244	+·367	1·50

The figures show conclusively the character of the oscillation of the barometric changes over the Central Provinces during the storm. The barometer fell slowly and steadily for five or six days and then rose rapidly for three days. This contrast between the slow fall in front and rapid rise in the rear of a cyclone is one of the more characteristic features of cyclones and cyclonic storms in India. The ratio of the total rise of the barometer in the rear of the storm to its fall when the storm was approaching was almost exactly the same at all these stations, whilst the actual amounts were considerably greater at Pachmarhi than at the neighbouring plain stations. The following table states the facts in a somewhat different manner, and shows clearly the identity in character of the barometric wave or oscillation during the storm throughout the Central Provinces :—

PAIR OF STATIONS.	Ratio of fall at pair of stations.	Ratio of rise at pair of stations.
Pachmarhi to Nagpur	1·26	1·20
Pachmarhi to Hoshangabad	1·09	1·12
Pachmarhi to Jubbulpore	1·52	1 50

The centre passed within a few miles of Nagpur and Hoshangabad, and at nearly the same distance as it passed to the west of Pachmarhi. These figures hence show that the barometric movement was considerably greater at Pachmarhi than at the neighbouring plain stations, and hence further, that the seat of most active ascensional movement was at an elevation considerably above that of Pachmarhi.

The Simla and Ludhiana observations show that the storm only affected the air pressure at these stations for about 48 hours. It is probable that the storm centre passed nearer to Simla than to Ludhiana. The storm was also breaking up at the time, and hence the conditions were somewhat different from those prevailing in the Central Provinces during its passage. The observations, however, show distinctly that the barometric oscillation during the passage of the storm was considerably greater at Simla than at Ludhiana, and hence appear to confirm the conclusion based on the Pachmarhi, Nagpur, and Hoshangabad observations.

The character of the storm is fully indicated by these facts. The seat of the transformation of energy was at a very considerable elevation, certainly higher than Pachmarhi (3,500 feet) and probably than Simla (7,000 feet). It is, therefore, rather to be classed with the cyclonic storms of the rains proper, than with those of the transition periods.

The chief features of these storms of the rains are :—

1st—Their remarkable vitality and prolonged existence, more especially when compared with the May and October cyclones.

2nd—The comparative feebleness and irregularity of the cyclonic circulation near the Earth's surface.

3rd—The excessive rainfall which they frequently give to the area over which they pass. If they advance towards the Himalayas, they usually break up in the immediate neighbourhood of these hills, and occasionally give a deluge of rain to the submontane districts when breaking up, which in its intensity is almost comparable with the sudden and enormous downpour that accompanies the breaking up of a waterspout or tornado. One example of this has been given in the present Memoir, in the brief account of the cyclonic storm of 1st to 14th September, pages 138-9. Another even more remarkable example was the rainfall in the Bijnor district on the 18th September 1880, during the breaking up of the cyclonic storm which caused a large landslip at Naini Tal. The following gives the rainfalls on that day at the raingauge stations in that district.

Nagina	. 32·40 inches.	Dhampur	. 30·40 inches.
Najibabad	. . . 28·50 inches.		

4th—The paths of these storms appear to be almost entirely independent of the geographical features of the country over which they pass. The only mountain ranges in India which are of sufficient altitude or mass to break them up or deflect them, are the Himalayas and Afghan mountains.

Barometric depression at or near the centre.—The following table gives the lowest barometer actually observed within the storm area on the days and at the hours named :—

Date.	Hour.	Ship or place of observation.	BAROMETER.		Distance and bearing of centre from position of place of observation.
			Reduced to sea-level.	Variation from normal.	
			"	"	
Sept. 14th . .	8 A.M.	Diamond Island	29·567	—·257	30 miles to N.-E.
" " . .	4 P.M.	Ditto .	29·560	—·191	90 miles to N.-W.
" 15th . .	4 P.M.	S. *Frankistan* .	29·540	—·194	140 miles to N.-N.-E.
" " . .	4 P.M.	*Canopus* . .	29·330	—·360	125 miles to S.-S.-E.
" 16th . .	1-30 A.M.	*Coleroon* . .	29·050	—·660	80 miles to W.-S.-W.
" " . .	2-30 A.M.	False Point .	28·850	—·800	A little to the S.-E. of False Point.
" " . .	8 A.M.	Cuttack . .	29·375	—·208	20 miles to W.-N.-W.
" " . .	4 P.M.	Sambulpur .	29·380	—·206	25 miles to N.-S.-W.
" 17th . .	8 A.M.	Nagpur . .	29·503	—·242	60 miles to E.-N.-E.
" " . .	4 P.M.	Ditto . .	29·382	—·254	20 miles to N.
" 18th . .	8 A.M.	Ditto . .	29·527	—·189	70 miles to N.-N.-W.
" " . .	4 P.M.	Jubbulpur .	29·493	—·166	110 miles to W.
		Saugor	29·431	—·242	40 miles to S.
" 19th . .	8 A.M.	Jhansi . .	29·516	—·178	40 miles to W.
" " . .	4 P.M.	Agra . .	29·460	—·178	45 miles to S.-S.-W.
" 20th . .	8 A.M.	Meerut . .	29·627	+·009	15 miles to S.-W.
" " . .	4 P.M.	Simla . .	23·102*	—·098	Depression filled up.

* Not reduced to sea level.

The preceding data show that the depression at the centre probably did not exceed three-tenths of an inch when the storm was crossing Tenasserim, the Gulf of Martaban, and Lower Burma. It increased rapidly in amount as the storm advanced across the Bay of Bengal and approached the Orissa Coast, and the barometer at False Point, when the storm centre was passing a few miles south of it, was about eight-tenths of an inch below the normal. It is hence probable that the depression at the centre was at least one inch at that time. The storm filled up partially as it crossed Orissa, and the depression at the centre diminished in six hours to about three-tenths of an inch. It was practically unchanged in amount during the next 72 hours, but again filled up rapidly as it approached the Himalayas, at which time the storm was giving a deluge of rain to the submontane districts of Umballa and Saharanpur. On the 20th, the depression at the elevation of Simla was less than the twentieth of an inch, and at the level of the plains the barometer was actually slightly above the normal in the centre of the cyclonic area. The storm filled up very rapidly on approaching the hills, and disappeared during the afternoon and evening of the 20th.

Rainfall.—The distribution of rainfall in cyclonic storms is a question of much importance.

In the year 1888 rainfall was measured daily at 6 P.M. at the rainfall recording stations, and the data given in Appendix A are based on these measurements.

The following gives a statement of the heaviest district rainfall for each day during the progress of the storm from the time of its reaching the Orissa coast to its dissolution in Upper India:—

Sept. 16th.—The storm centre at 6 P.M. was passing from the Sambalpur district into the Bhandara district. The largest district rainfalls during the previous 24 hours were—

PROVINCE.	District.	Average rainfall during previous 24 hours.
Central Provinces	Bhandara . .	1·17 inches.
	Sambalpur . .	1·05 „

Sept. 17th.—The storm centre at 6 P.M. was a few miles north-west of Nagpur. The following gives the largest district rainfalls in India during the previous 24 hours:—

PROVINCE.	District.	Average rainfall during previous 24 hours.
Central Provinces.	Bhandara . . .	2·86 inches.
	Betul . . .	2·77 „
	Seoni . . .	2·32 „
	Raipur . . .	2·13 „
	Balaghat . .	2·10 „

Sept. 18th.—The storm centre was moving northwards and approaching Bhopal at 6 P.M. The largest district rainfalls of the previous 24 hours (exceeding two inches in amount) were—

Province.	District.	Average rainfall of previous 24 hours.
Central Provinces	Betul	5·25 inches.
	Nagpur	2·74 ,,
	Hoshangabad	2·71 ,,
	Chhindwara	2·29 ,,
	Saugor	2·04 ,,
North-West Provinces.	Kumaon	4·51 ,,
	Bijnor	3·58 ,,
	Muzaffarnagar	2·78 ,,
	Bulandsharh	2·56 ,,
	Garhwal	2·30 ,,

Sept. 19th.—The storm centre was moving northwards and passing to the west of Agra at 6 P.M. The following gives the district rainfalls during the previous 24 hours exceeding three inches in amount :—

Province.	District.	Average rainfall of 24 hours preceding 6 P.M.	Greatest rainfall in district.
North-West Provinces.	Agra	6·06 inches	9·00
	Bulandshahr	5·32 ,,	6·40
	Alibagh	4·65 ,,	7·00
	Muzaffarnagar	4·62 ,,	6·90
	Saharanpur	4·30 ,,	8·20
Punjab	Kumaon	3·43 ,,	5·80
	Muttra	3·26 ,,	4·70
	Budaun	3·16 ,,	5·90
	Delhi	4·40 ,,	5·90
	Simla	3·90 ,,	5·50
	Gurgaon	3·40 ,,	6·80
	Rohtak	3·40 ,,	5·60

Sept. 20th.—The storm centre passed from the plains into the Simla Hills on the afternoon of the 20th and was north of Simla at 6 P.M. The following gives district rainfalls during the previous 24 hours exceeding three inches in amount :—

Province.	District.	Average rainfall of 24 hours preceding 6 P.M.	Maximum rainfall in district.
Punjab	Ludhiana	3·80 inches.	9·00
	Delhi	3·30 ,,	5·80
	Karnal	3·20 ,,	5·90
	Simla	5·00 ,,	9·50
	Umballa	7·90 ,,	10·30
North-West Provinces.	Saharanpur	6·51 ,,	9·50
	Bijnor	4·00 ,,	4·72
	Muzaffarnagar	3·90 ,,	6·00
	Meerut	3·19 ,,	4·55
	Dehra	3·33 ,,	4·65

On the 21st the rainfall averaged less than 1 inch in every district in India.

The average district rainfall as given above depends, of course, considerably upon the size of the district and the number of rainfall registering stations. When it is taken into consideration that the rainfall given in the previous statement occurred during the 24 hours whilst the storm centre was moving from its position of the preceding day to that of the day in question, it is evident—

1st—That the heaviest and most intense rainfall occurred near the centre and in front of it, and that this was more especially the case in the latter part of its existence. Very heavy rain began to fall in the districts at distances of 100 or 150 miles in front of the storm, and continued until the centre had passed to some little distance beyond the districts in its advance.

2nd—That the rainfall did not increase in intensity during its westward passage across Orissa and the Central Provinces, but increased rapidly in amount as it marched northwards, and was excessive in amount in the districts in Upper India near the hills over which it passed during the last 30 hours of its existence.

3rd—That the rainfall was heaviest over and near the track of the storm centre, and was larger in amount at the same distance to the east than to the west of the track. As the storm advanced northwards, the rainfall increased and concentrated, and the contrast between the rainfall in the east and west quadrants became more marked. The following statement gives a few facts in support of this conclusion :—

Date.	Rainfall at Station west of Centre.		Rainfall at Station near Centre.		Rainfall at Station at approximately same distance east of Centre.	
	Station.	Amount.	Station.	Amount.	Station.	Amount.
17th .	Neemuch .	0·30	Jhansi . .	2·67	Allahabad .	0·55
18th .	Jeypore . .	0·28	Agra . .	1·25	Lucknow . .	0·23
19th .	Sirsa . .	*Nil*	Meerut . .	2·40	Bareilly . .	2·85
20th .	Ludhiana .	3·52	Umballa . .	8·40	Roorkee . .	7·20

It is, however, shown more clearly by the distribution of rainfall as given in the charts, Plates XXVII and XXVIII.

4th—The preceding data also show that previous to, and in the earlier stages of the storm, and independently of any action due to the storm, there was a tendency to the occurrence of heavy rainfall in the western districts of the North-Western Provinces through which the storm afterwards passed.

Air motion accompanying the Storm.—There are several points of interest in connection with the air motion of the storm. These are discussed in detail in the following paragraphs.

One way of viewing a cyclonic storm is to consider it as a mass rotating in circles or ellipses round an axis and carried forward. The resultant motion at any point according to this view is the combination of the rotatory motion at the distance of point from the axis, and the motion of translation of the mass. In the cyclone under question, the storm, when crossing the Bay of Bengal, was moving with a westward velocity of 14 miles per hour approximately. Hence in the north quadrant, where the motion due to translation was in the same direction as that due to rotation, the winds should have exceeded those at the same distance from the centre where the two motions were opposed by double the velocity of translation of the storm, or, roughly speaking, 30 miles per hour. The following data and facts, however, appear to show that this method of analysing the air motion of a cyclonic storm is not satisfactory or correct.

According to the general experience of sailors, the easterly winds in the northerly quadrant of the cyclonic storms of the rains are very feeble when compared with the westerly winds in the southerly quadrant, and, in fact, these storms were formerly described as westerly gales, and not as cyclonic storms at all by sailors. It is very difficult to make an exact and thoroughly satisfactory comparison of the strength of the winds in different quadrants, as the conditions of exposure of the wind-recording instruments differ very largely at different stations. The following data indicate the strong probability that the same distinction obtained in this storm between the winds in the north and south quadrants as usually holds in the cyclonic storms of the rains (or "westerly gales") which march in a westerly direction to the Orissa or North Madras Coast.

Date.	Station.	Wind direction.	Velocity in miles per hour.	Percentage ratio of actual to normal velocity.
14th . .	Gopalpur	N.-W.	13	186
	Saugor Island	N.-W.	7	70
15th . .	Saugor Island	N.-N.-W.	9	90
	Gopalpur	N.-W.	7	100
16th . .	Saugor Island	E.-S.-E.	24	240
	Gopalpur	S.-S.-W.	11	157
17th . .	Saugor Island	E.-S.-E.	20	200
	Gopalpur	S. .	30	429

When the positions of these stations with respect to the storm are taken into consideration, and it is also remembered that the exposure of the anemometer at Saugor Island is much more open than at Gopalpur, it is evident that the data given in the table establish—

1st—That the winds in the western quadrant of the cyclone were very feeble compared with those in the eastern quadrant;

2nd—That the winds in the southern quadrant were stronger than those in the northern.

Another feature of importance was the comparative lightness of the winds in the central area to the north and north-north-west of the centre of the storm after it recurved to the north.

The following table gives the average velocity of the wind from the 17th to the 20th at stations near and to the west of the centre :—

STATION.	AVERAGE VELOCITY OF WIND PER HOUR ON SEPTEMBER				Average hourly velocity, 17th to 20th September.	Normal hourly velocity, September.	Ratio.
	17th.	18th.	19th.	20th.			
Hoshangabad	0	0	2	4	1·5	2·5	0·6
Pachmarhi	8	9	10	7	8·5	5·5	1·5
Saugor	4	1	6	8	4·75	3·5	1·3
Jhansi	4	10	8	12	8·5	3·0	2·8
Agra	4	6	7	12	7·25	4·0	1·8
Delhi	1	4	5	7	4·25	4·0	1·06
Meerut	2	2	6	8	4·5	2·0	2·25
Ludhiana	2	2	2	6	3·0	2·0	1·50

The winds in the eastern quadrant, even at considerable distances from the centre, stand in marked contrast with the winds near the centre and in the north-western quadrant. The following table gives data of several stations for the same period as that of the preceding table :—

STATION.	AVERAGE VELOCITY OF WIND PER HOUR ON SEPTEMBER				Average hourly velocity, 17th to 20th September.	Normal hourly velocity, September.	Ratio.
	17th.	18th.	19th.	20th.			
Jubbulpore	6	6	12	8	8·0	3	2·7
Nowgong	7	7	6	6	6·5	2	3·2
Allahabad	9	14	13	6	10·5	3	3·5
Sutna	15	17	15	9	14·0	6	2·3
Lucknow	5	12	14	12	10·8	3	3·6
Bareilly	2	3	7	15	6·8	3	2·3
Roorkee	1	2	6	5	3·5	2	1·8

A comparison of the last column of this table with that of the preceding table, shows clearly the greater velocity of the wind to the east and north-east of the centre, than near the centre or to the north-west and west of it.

The only satisfactory explanation of these facts appears to be that in the area of cyclonic circulation, the ascensional movement in the storm area during the period under discussion occurred chiefly in front, or to the north of the centre. The horizontal movement was hence weakest in this portion of the storm area. The ascensional movement was supported mainly by the humid current from the Bay of Bengal. Hence the horizontal movement was greatest to the south-east, east, and north-east of the centre, where this humid current was feeding into the cyclone area, and the uptake or ascensional movement was not large in amount.

It is not necessary to give data on this point further than the above, as they are cited chiefly to show that the air motion in this, as in the cyclonic storms of the rains generally, differs very greatly in intensity in the different quadrants, and that the motion cannot be resolved into a translation in a horizontal direction, together with a rotation about a vertical axis, or even about an axis inclined to the vertical.

South-west monsoon trough of low pressure.—A reference to the storm track charts given in the Handbook of Cyclonic Storms in the Bay of Bengal will at once show that the storms of the rains proper follow one of the two following general tracks:—

(*a*) The large majority of them move westwards along a narrow belt of country separating the area in which the westerly winds of the Bombay current usually prevail exclusively from an area to the north in which the easterly winds of the Bay of Bengal current blow steadily during the rains.

(*b*) A small proportion move in a general northerly direction into Bengal or Behar.

The long narrow belt or area along which the great majority of the south-west monsoon storms advance, forms a trough of low pressure during the rains which usually stretches from Sind or the West Punjab across East Rajputana, Chutia Nagpur, into Orissa. Its position in July is fully indicated by the following barometric data for stations in five lines or sections running across the trough:—

—	Station.	Mean pressure in July.
1st Line or section.	Dera Ismail Khan	29·407″
	Mooltan	29·400″
	Jacobabad	29·376″
	Kurrachee	29·487″
2nd Line or section.	Neemuch	29·497″
	Ajmere	29·480″
	Jeypore	29·469″
	Sirsa	29·428″
	Delhi	29·445″
	Roorkee	29·458″
3rd Line or section.	Hoshangabad	29·541″
	Jubbulpore	29·503″
	Sutna	29·464″
	Allahabad	29·471″
	Gorakhpur	29·479″
4th Line or section.	Sambulpur	29·492″
	Hazaribagh	29·471″
	Patna	29·491″
	Purneah	29·513′
5th Line or section.	Vizagapatam	29·564″
	False Point	29·523″
	Saugor Island	29·509″
	Calcutta	29·507″
	Berhampore	29·508″
	Dhubri	29·575′

The preceding data prove that the mean position of the axis of the ugh of low pressure in July, is a nearly straight line joining the stations of sa, Sutna, Hazaribagh, and Saugor Island.

The more important meteorological features of this trough are—

(1) Light and variable winds as compared with those which obtain at stations either to the north or to the south of the trough. The following wind data establish this conclusion:—

—	STATION.	STEADINESS.	VELOCITY.
		Average percentage, July.	Normal mean daily wind velocity, July.
To north of the trough of low pressure.	Peshawar	47	106
	Dera Ismail Khan	48	58
	Lahore	34	79
	Roorkee	33	71
	Gorakhpur	52	67
	Purneah	53	71
	Patna	41	87
	Calcutta	65	127
In the trough of low pressure.	Mooltan	33	81
	Sirsa	19	114
	Jeypore	25	148
	Sutna	45	226
	Allahabad	7	97
	Gya	19	70
	Hazaribagh	19	203
	Saugor Island	59	341
To south of the trough of low pressure.	Jacobabad	56	128
	Kurrachee	83	428
	Neemuch	78	293
	Ajmere	64	167
	Jubbulpore	65	120
	Hoshangabad	77	107
	Sambalpur	45	86
	Chanda	70	150
	False Point	64	252
	Gopalpore	72	272

(2) There is a marked tendency to heavier rainfall in this intermediate area than in the districts immediately to the north and south. The rainfall varies, however, to so large an extent with local conditions that it is not possible to prove this satisfactorily by data for a few stations. A reference to Mr. Blanford's rainfall chart of India will show this feature in the rainfall distribution in India.

(3) This trough is the most usual track of cyclonic storms which occur during the months of June, July, and August. The following gives a statement of the number which advanced along it, and of

those which followed a different course in the months of June, July, August, and September during the period 1877-88 :—

—	Number of storms which travelled along the trough.	Number of those storms which did not travel along the trough.
June . . .	7	7
July . . .	19	4
August . . .	13	8
September . .	15	8
TOTAL .	54	27

The figures for July are very noteworthy, as the trough of low pressure is usually most marked in that month. This is of course due to the fact that the monsoon currents are usually strongest and steadiest in July.

(4) There is one peculiarity in the trough of low pressure which is of considerable importance in connection with storms. During the rains, pressure in the Indian area is highest in the south and lowest in the north. The gradients vary very considerably, being of course steepest when general and heavy rain is falling in Northern India, and small when there is a partial or complete break in the rains. The changes in the gradients are almost entirely produced by barometric oscillations in Upper India (*i.e.* in the Punjab, Sind, and Rajputana). One effect of a rapid rise of pressure in this part of India will evidently be either to fill up the western portion of the trough, or to shift the position of the western half in an easterly direction. In the latter case the trough may run in a curved line from the Central Punjab or the western districts of the North-Western Provinces southwards into the Central Provinces or Central India and thence in an easterly direction into Orissa. Such a change in the position of the trough will occasionally, if not generally, occur in the month of September, when the monsoon currents retreat from Upper India. The Bombay current then blows across the Bombay coast chiefly into the Peninsula, whilst the Bengal current retreats down the Gangetic plain. A rapid increase of pressure in North-west India invariably accompanies this change. Hence, if the Bengal current continues to prevail in Bengal and Behar, it is clear that at such a time the trough of low pressure will tend to run from the South-east Punjab or the North-West Provinces into Central India or the Central Provinces and thence to Orissa.

Conclusions derived from preceding remarks.—The preceding facts have hown clearly that the most important feature of the storm was rainfall, and also hat the condensation of aqueous vapour released the energy which maintained he cyclonic storm. It has been proved that during nearly, if not the whole, of its xistence on land, rainfall and, therefore, aqueous vapour condensation occurred nost rapidly and largely in front of the advancing cyclone, and it has also been shown that certain features of the air motion, more especially during the latter part of its existence, when the rainfall was heaviest, are only explicable on the following assumption :—

1st.—That the ascensional motion occurred most largely in front of the centre.

2nd.—That the chief indraught of the humid current which maintained the cyclone took place in the eastern quadrant, and hence that the horizontal movement of the air was greatest and most marked to the east, and south-east of the area in which ascensional motion was most rapid.

The following conclusions appear to follow from these inferences :—

1st.—In consequence of ascensional motion occurring more largely in front than in the rear of the storm, the isobars should form oval curves with their longest diameter approximately in the direction of motion. This was practically the case throughout the present storm, for as it recurved, the direction of the longest axis of the oval cyclonic area shifted from east and west to north and south. Moreover, when recurving, the area of heavy rainfall was transferred from the western to the northern quadrant, and the barometer began to fall at considerable distances to the north of the centre, thus producing the northerly elongation of the cyclone area. The phenomena during recurvature were, in this respect, at least, the same as those accompanying and determining the path when unchanged.

2nd.—A further consequence of the same action of uptake and, therefore, of the rapid fall of barometer occurring at some distance in advance of the centre, is that the distance over which the barometer is falling extends to a much greater distance in front than the rise in the rear, and as the amounts of the fall in front and rise in the rear are approximately the same, and the latter takes place in a much shorter distance, the rate of rise during the passage of these cyclonic storms is much greater than the preceding fall, and the steepest gradients are in the rear of these cyclones. Hence the strongest winds are, as in the present case, sometimes, if not frequently, not found in the region of steepest gradients. This is especially observable in the charts of the 18th, 19th, and 20th (*vide* Plates XXIV, XXV and XXVI), when the storm was moving northwards and only fed by one moist current and not by two, as is occasionally the case when storms pass westwards through the Central Provinces into Western or North-Western India.

3rd.—Again, in consequence of the elongation, there will be a vagueness about the position of the centre of the depression and of the cyclonic circulation. These will not necessarily coincide with the centre of figure of the cyclonic ovals, but will tend to be displaced to the rear. This is observable in several of the charts of the storm under consideration, and more especially in that of the 18th, when the storm was recurving.

Causes determining the track of the storm.—The preceding remarks enable a partial explanation of the track of the storm to be given.

The rains ceased in Upper India in the first week of September 1888, and a rapid rise of pressure occurred in that region. The Bombay monsoon current withdrew from the north, and perhaps the centre of the Arabian Sea. The discussion of the meteorology of the 11th and 12th September on page 143 has shown fully, that in consequence of the rapid increase of pressure in North-Western India, the trough of low pressure when the cyclonic storm was entering the Indian area ran in a curved line through the western districts of the North-Western Provinces, the eastern districts of Rajputana and Central India, the Central Provinces and Orissa, and was continued across the head of the Bay into Lower Burmah. The storm advanced along this trough through its whole length. This position of the trough of low pressure is of occasional occurrence in the month of September, and is most strongly marked when the Bombay current retreats earlier than usual from Upper India, as was the case in September 1888.

A reference to the storm chart of September, published in the Handbook of Cyclonic Storms in the Bay of Bengal, will show that a considerable proportion of the storms in that month follow curved tracks, coinciding approximately with the deflected position of the trough described above.

Hence it is certain there is some connection or relation between the position of the trough of low pressure, and of the paths of the south-west monsoon storms. As the former is the antecedent phenomenon in point of time, it is quite sufficient, for purposes of forecasting these storm tracks, to recognize the relation. It is, however, desirable to trace, so far as possible, the nature of the relation between the two phenomena.

It has already been stated that this trough, or intermediate area, is one of slightly deficient pressure, and of light and variable winds, and hence one in which the resistances to the motion of a large atmospheric eddy are smaller than they would be in a strong opposing current, such as the Bombay current must be to a storm moving westwards through the Central Provinces.

The intermediate area is also one of much interaction of two humid currents and hence of greater rainfall than outside the area. There is consequently in this area frequent and strongly marked tendency to local and concentrated rainfall, conditions which, according to the condensation theory, are favourable to the maintenance and development of cyclonic storms. The tendency to local and excessive rainfall was very strongly shown on the 17th and 18th of September 1888 in that portion of the trough which ran through the western districts of the North-Western Provinces.

The peculiar position of the trough of low pressure was due to the fact that the Bombay current had retreated from North-Western India and the northern portion of the Arabian Sea, and was also feeble in the southern half of the Arabian Sea. These conditions were such as to make it improbable that this current would feed strongly into the cyclone vortex, and as a matter of fact, it failed to do so almost entirely. The storm, even when in the Central Provinces, produced no perceptible effect on the general strength of that current in the Arabian Sea. It was maintained throughout almost entirely by the humid current from the Bay of Bengal.

The following remarks on the parts played by the two currents in the case of the cyclonic storms which advance into the Central Provinces or Central India are given chiefly as suggestions.

The more fully the cyclonic storms and cyclones of the south-west monsoon which enter India from the adjacent seas are studied, the more probable does it appear to be :—

1st.—That they almost, without exception, originate in the Bay of Bengal.

2nd.—That the heaviest and most intense rainfall, and hence also the largest amount of ascensional movement, occur in advance of the centre of the storm, and not at or near the centre.

3rd.—That the advance of the storm (and therefore the phenomena depending upon the advance) take place towards, and are determined by, the direction of the area of greatest and most intense rainfall with respect to the centre.

Hence, when a south-west monsoon storm is advancing westwards from the Bay across the Orissa coast, the rainfall which is then mainly due to the Bay of Bengal current, is most intense to the west of the centre. Hence ascensional motion is strongest, and therefore also horizontal motion is feeblest in that quadrant, and the horizontal motion is consequently necessarily strongest to the north and east of the centre. As it continues to advance westwards, the Bay current is retarded by the friction of the land surface. If the Bombay current be strong, it commences to feed into the cyclone, and its action increases with the westward advance of the storm, whilst that of the Bay of Bengal tends to diminish. The result of the indraught of this second humid current in the south quadrant, is mainly to supplement the decreasing action of the Bay of Bengal current, and hence it assists in maintaining, or increases, the ascensional motion in the western quadrant, and at the same time brings the area of chief ascensional motion and aqueous vapour condensation round slightly towards the north. Hence in such cases when both currents are strong, storms tend to pass across the Peninsula with a tendency to recurve very slightly to north. The storm track charts of July and August, when both currents are usually in full strength, published in the Cyclone Handbook, show this clearly.

On the other hand, if the Bombay current be weak, and fail to feed largely into the cyclonic circulation, the retardation of the Bay of Bengal current caused by the friction with the land surface, will tend to cause the area of most active ascensional movement or most rapid condensation and most intense rainfall to move round from the western to the northern quadrant. There will hence be a very marked tendency for storms which pass westwards from the Bay of Bengal under such conditions to recurve round to north. As already stated, the storm track chart of September given in the Handbook of Cyclonic Storms in the Bay of Bengal shows this tendency very strongly, and the present storm is an additional and very striking example.

II.—Discussion of the more important features of the second Storm.

Origin of the second storm.—The storm of the last week of October originated in the Bay of Bengal under what may be termed the ordinary conditions of the formation of cyclonic storms during the retreating south-west monsoon current. It formed in a small area to the south-west of the Andamans, and north-west of the Nicobars, in about Lat. 10° N. and Long. 90° E. At the time of its formation the retreating south-west monsoon was giving north-east winds with moderate to heavy rain to the Carnatic, and squally weather to the adjacent portion of the Bay. The general pressure conditions obtaining in India on the 24th, 25th, and 26th of October, may be very briefly described as follows :—Pressure was unusually high in Northern India (about ·05″ above the normal of the day in the Punjab), and moderately steep gradients favouring northerly to westerly winds obtained in that area. Pressure was also in moderate excess in the north and east of the Bay and in Burma, and was lowest in the south of the Bay, the Coromandel, and Malabar and Konkan coast districts. Pressure was about a tenth of an inch higher in the north than in the south of the Bay, and moderate gradients for north-east winds were established in the north and centre of the Bay. The area in the south of the Bay (south of Lat. 12°) was one of uniform and low pressure. Strong west and south-west winds were blowing in the south of the Bay, south-east winds at Port Blair, east winds in the centre of the Bay, and north-east winds on the Coromandel coast. The prevailing winds in the southern half of the Bay hence indicated clearly that the south-west current in the south of the Bay was recurving in the normal manner, in consequence of which it was giving general rain to the Carnatic and Southern India.

In the eastern portion of this belt of low uniform pressure, where the south-west winds were commencing to recurve, was a small area characterized by the following features :—

1st.—It was the only part of the Bay in which light, variable, and unsteady winds prevailed.

2nd.—Weather was somewhat unsettled and squally with heavy rain on the 24th, 25th, and 26th. The area extended to some distance northwards on these days, the weather became more unsettled, the squalls heavier and more frequent, and the rainfall more intense. The disturbance developed rapidly, and the barometric depression thus produced intensified into a cyclonic storm which began to form on the 27th, and increased in extent and intensity on the 28th and 29th, and was a severe cyclone on the 30th and 31st.

Track of Storm centre.—The following gives the track of the storm :—

Day.	Hour.	Position of Centre.		Distance passed over during previous interval.	Average rate of motion during previous interval.
		Latitude N.	Longitude E.		
29th . . .	Noon	11° 25′	88° 0′	...	...
30th . . .	Noon	12° 0′	85° 30′	170	7 miles.
31st . . .	8 A. M.	12° 40′	82° 40′	205	10¼ "
	Noon	12° 45′	82° 0′	42	10½ "
	4 P. M.	13° 10′	80° 25′	...	...
	9-30 P. M.	Crossing coast at Madras.		105	11 "
1st	8 A. M.	13° 15′	79° 30′	45	4 "
	4 P. M.	13° 15′	79° 15′	25	3 "

The storm formed on the 26th and 27th in about Lat. 10° N. and Long. 90° E., and began to move along the usual path taken by storms which form near and to the north-west of the Nicobars. It was in Lat. 11½° N. and Long. 89° E. at noon of the 28th and continued to move in a W. by N. course with approximately uniform velocity from that date until it struck the Madras Coast. Its velocity averaged about 9 miles per hour during this period. It did not increase much in velocity as it approached the coast, although it probably increased in intensity.

Storms of the October Transition Period.—The present storm was a storm of the October Transition Period, and hence one of comparatively low elevation. The following gives briefly the chief reasons for the assumption that these storms are of comparatively low elevation :—

1st.—They are formed in the retreating south-west humid current, which is necessarily at this time a shallow current when compared with its depth in July and August, when it extends northwards as far as the Himalayas. Its shallowness is further proved by the fact that the retreating current when it recurves, and gives rain in October and November to Southern India, discharges its moisture almost entirely in the coast districts and first low line of hills, and gives very little to the eastern flanks of the West Ghâts, in this respect contrasting strongly with the precipitation the same current gives in July and August to the southern face of the Himalayas.

2nd.—These storms, when viewed from a distance outside the storm area, appear as a comparatively low bank of clouds and give evident signs of extending upwards to no great elevation. For a convincing proof of this, it is only necessary to read Master Pilot Mr. Elson's account of the False Point Cyclone of September 1885, as viewed by him from the Sandheads (*vide* Cyclone Handbook, page 171).

3rd.—Hills of moderate elevation (2,000 to 4,000 feet high) exercise a most powerful influence in either breaking them up or in defecting them. Numerous examples might be given of this feature from the cyclonic storms of October and November of the past 20 years. On the other hand, not more than one or two (doubtful) examples could be given of such storms having crossed unbroken a range of hills exceeding 2,000 or 3,000 feet in elevation.

Rainfall accompanying the cyclone.—The data for the discussion of this feature are much less in amount for the two cyclones of October and November 1888 than for the September storm, as the former storms broke up very shortly after reaching land. They are, however, sufficient to show that the rainfall was excessive in the area passed over by these storms. They are also in favour of the supposition that the rainfall area extended much further in front of, than to the rear of, the cyclone, and that it was most intense at some distance in front of the centre of the storm. In other words, the rainfall area, although probably similar in shape to the storm area and with their longest diameters probably nearly coincident in direction, was not concentric with it. The centre of heaviest rainfall and of the rainfall area in the case of the Madras or second cyclone was to the west of the storm centre. The observations taken at Madras over which the centre passed, establish this very clearly :—

—	Hour of Observation.	Rainfall during interval since last observation since 28th.
Madras Astronomical Observatory.	Oct. 29th 12 P.M.	0·31
	„ 30th „	4·72
	„ 31st „	9·20
	Nov. 1st „	0·20
	„ 2nd „	0·65

The storm centre crossed the coast at Madras at about 9-30 P.M. of the 31st. If it be assumed that rain fell steadily at about the same rate during the whole of the 31st, which is probably not far from the truth, the preceding data show that upwards of 13 inches fell during the 48 hours before the approach of the centre and less than 2 inches during the 48 hours after it passed over Madras.

The Port Officer in his account of the storm stated that it rained continuously for 49 hours, *viz.*, from 8 A.M. of the 30th to 9 A.M. of the 1st. It hence rained continuously for 39 hours before the advent of the storm centre, and for only 10 hours afterwards. The total rainfall during this period of 49 hours at the Port Office was 14·23 inches, of which upwards of 12 inches fell before 10 P.M. of the 31st.

The following gives (less complete) rainfall data for other stations in the storm area :—

	STATION.	Distance from path of centre.	Hour.	RAINFALL REGISTERED ON				TOTAL.
				30th.	31st.	1st.	2nd.	
		Miles.						
North of path.	Vizagapatam	365	8 A.M.	*Nil.*	3·70	1·10	1·40	6·20
	Nellore	100	Noon	1·30	2·00	3·80	1·20	8·30
	Cuddapah	70	Noon	0·10	0·10	2·20	1·60	4·00
	Ongole	150	Noon	...	0·15	2·40	0·10	2·65
	Masulipatam	220	8 A.M.	...	0·25	2·50	0·32	3·07
	Coconada	290	Noon	...	1·85	2 90	0·24	4·99
Near path of centre.	Madras	*Nil.*	Midnight	4·72	9·20	0·20	0·65	14·77
	Saïdapet	10	Noon	2·50	4·90	7·00	0·70	15·10
	Tada	15	Noon	2·95	3·70	0·40	0·30	7·35
	Chittoor	10	Noon	...	6·00	0·20	0·25	6·45
South of path.	Chingleput	30	...	1·55	1·85	8·75	3·60	15·75
	Conjeeveram	25	...	1·15	0 50	6·70	2·25	10·60
	Vellore	30	Noon	...	6·05	...	0·20	6·25
	Arcot	30	Noon	0·25	0·18	5·55	0·15	6·13
	Cuddalore	110	Noon	...	...	...	0·10	0·10
	Negapatam	160	...	0·16	...	0·08	0·25	0·49
	Trichinopoly	180	4 P.M.	...	...	0·44	...	0·44
	Tanjore	170	...	...	...	...	1·10	1·10
	Madura	250	8 A.M.	1·10	...	...	...	1·10

The positions of these rainfall stations are shown in the chart prefixed to the Annual Reports on the Meteorology of India.

The preceding rainfall data show—

1st—That the rainfall was heaviest in and near the path of the centre.

2nd—That it diminished rapidly in amount from the sea coast to the interior.

3rd—That it diminished rapidly in amount to the north and south of the path of the centre, and extended much further to the north than to the south of the centre. It was large in amount on the sea coast at distances of 300 to 400 miles to thenorth of the track of the storm, whilst it was almost *nil* at a distance of 100 miles to the south.

4th—The rainfall was most intense in advance of the cyclone centre, and the line or narrow belt of heaviest and most intense rainfall, so far as can be judged from the limited data, very approximately coincided with the line of advance of the storm centre.

Peculiar features of the air movement in the storm area.—One important feature of the winds in the November and December cyclones is the great strength of the winds at very considerable distances from the centre in the north quadrant. It is very probable that the cyclonic rainfall which is due to the southerly or humid winds entering the storm area in the eastern quadrant is usually most intense in the western quadrant. Hence ascensional movement is most active in the western quadrant and the horizontal movement comparatively feeble. The horizontal movement of indraught is hence most strongly developed in the eastern and (perhaps to a slightly less extent) in the northern quadrant.

The following data show that this was undoubtedly the case in the present cyclone:—

STATION.	DISTANCE OF STATION FROM THE TRACK OF THE STORM.	AVERAGE VELOCITY OF THE WIND IN MILES PER HOUR FOR THE 24 HOURS ENDING 8 A.M. OF THE					Average wind velocity of period 29th to 2nd.	Ratio of wind velocity of period to normal.
		29th.	30th.	31st.	1st.	2nd.		
Negapatam	160 miles south of path	3	4	5	5	3	4	·90
Salem	140 miles south of path	1	2	1	1	2	1·4	·47
Madura	260 miles south of path	3	3	1	2	1	2	·67
Trichinopoly	190 miles south of path	3	3	4	7	4	4·2	1·05
Bangalore	40 miles south of prolongation of path	4	3	4	5	11	5·4	1·35
Madras	Near path	6	8	14	32	9	14	2·80
Masulipatam	210 miles north of path	9	9	9	31	9	13·4	3·35
Cocanada	290 miles north of path	15	22	28	28	22	23	3·06
Secunderabad	250 miles north	7	6	5	9	12	8	2·00
Sholapur	...	14	15	17	19	21	17·2	2·32

The following table gives a brief statement of the winds experienced by the S.S. *Sirsa* and *Goorkha* in the northern and southern quadrants of the storm:—

Vessel.	Date.	Position with respect to storm.	Character of winds.
Sirsa . . .	30th .	At Masulipatam, 400 miles north-west of the centre.	Strong breezes with heavy squalls.
Goorkha . . .	...	At Madras, 300 miles west of centre.	Light to moderate breezes.
Sirsa . . .	31st 8 A.M.	100 miles north-west of centre.	Hard gale with hard squalls.
Sirsa . . .	31st 2 P.M.	50 miles north of centre .	Terrific gale.
Goorkha . . .	31st .	From 50 to 80 miles south of Madras during day.	Moderate winds during day.

The comparison of the winds, as experienced by the *Sirsa* and *Goorkha* on the 30th and 31st at nearly equal distances from the centre in the northern and southern quadrants, shows most strongly the great difference between their force. Hurricane winds prevailed near the centre in all directions. In the southerly quadrant, winds of force 8 were probably not experienced at a distance of more than 50 or 60 miles south of the centre near the Coromandel Coast, whilst in the northern quadrant they extended to at least 250 or 300 miles. The average force of the winds on the 31st, during which the storm approached and passed over Madras, was (judging from the anemometric data) as great at Musulipatam and Cocanada as at Madras. A comparison of the wind amounts at Salem, Trichinopoly, Madura, and Negapatam at distances of 120, 160, 200, and 160 miles to the south of the track of the storm with the amounts registered at Sholapur and Secunderabad (each about 300 miles north of the track) shows that the same relation obtained generally over the whole area of the cyclonic circulation.

The facts of these storms hence appear to establish that when they are fully formed—

(*a*) The indraught is chiefly maintained by a humid current from the south of the Bay which is in fact the retreating south-west monsoon and which enters the cyclone area chiefly in the eastern quadrant.

(*b*) The ascensional movement and rainfall in each case when a deep depression and intense storm has formed in the south of the Bay and is advancing westwards occurs most largely in front of the storm or in the western quadrant.

(*c*) In consequence of the ascensional movement occurring chiefly in the western quadrant, the winds of indraught extend to very considerable distances from the centre to the north and east, and the right advancing quadrant is peculiarly dangerous, more especially when the storm is approaching the Coromandel Coast.

(*d*) As a further consequence of this action, and also of the friction offered by the land to the air motion in the western quadrant, the winds in the southern quadrants of these storms are comparatively light, except quite near to the centre.

(*e*) The practical application of these facts is that ships should if possible avoid the right advancing quadrant of these storms if they are lying at anchor at a port on the Coromandel Coast when a cyclone is approaching. They should, when the warning or danger signal is hoisted, endeavour to ascertain as early as possible the probable track of the centre, and pass into or remain if possible in the southern quadrant.

This rule was observed by the Captain of the *Goorkha* and violated by the *Bhandara*. The *Sirsa* ought to have adopted a different course shortly after she left Masulipatam and passed to the eastwards or north-eastwards instead of the southward. By continuing on the latter course too long she was carried into the heart of the cyclone, and experienced a protracted spell of hurricane winds and cyclonic weather.

Barometric depression in the storm.—The following table gives data showing the lowest observed barometer in the area of depression at various times during the existence of the storm:—

Day.	Hour.	Ship or place of observation.	Position.		Barometer reduced.	Variation of Barometer from normal.	Distance and bearing of centre.
			Latitude, North.	Longitude, East.			
			° ′	° ′			
Oct. 26th	Noon	S. *Victoria Regina*	7 42	89 17	29·94	+·04	160 miles to N.-N.-E.
27th	Noon	S. *Davenby Hall* .	9 24	90 20	·90	0	45 miles to N.-W.
—	4 P.M.	S. *Ditto* . .	9 50	90 30	·75	—·01	55 miles to N.-W.
28th	Noon	S. *Victoria Regina*	11 57	90 20	·86	—·03	90 miles to W.-S.W.
29th	4 P.M.	S. *Davenby Hall* .	12 0	90 50	·77	—·13	250 miles to W.
30th	Noon	S. S. *Peshwa* .	11 57	83 57	·82	—·06	100 miles to E.
31st	8 A.M.	Madras . .	13 4	80 14	·73	—·16	160 miles to E.
	4 P.M.	Madras . .	13 4	80 14	·49	—·28	22 miles to W.-E.
	6 P.M.	S. S. *Clive* . .	In centre.		·19	—·63	50 miles to N.-W.
	7 P.M.	S. S. *Sirsa* . .	Near	centre	28·82	—1·00	100 miles to N.-W.
	9-50 P.M.	S. S. *Bhandara* .	Near	centre	29·15	—·67	40 miles to W.-N.W.
	10-30 P.M.	Madras .	13 4	18 14	28·96	—·92	16 miles to N.-W.
Nov. 1st	8 A.M.	Madras . .	13 4	18 14	29·71	—·15	60 miles to W.

Circumstances attending the breaking up of the Cyclone.—It was stated in the enquiry on the loss of the S. *Vaitarna*, that the present cyclonic storm passed across the Peninsula from Madras to Mangalore and thence into the Arabian Sea. If it be assumed that a cyclonic storm has its ordinary meaning, *viz.*, a cyclonic circulation with a definite centre at which the barometer stands lower than at the outskirts, and in the neighbourhood of which the strength of the winds is much greater than their normal force and the weather is stormy, then the observations appear to establish that the present cyclonic storm broke up in the Peninsula, and did not cross the West Ghâts at all.

When the storm crossed the Madras coast at 10 P.M., it was travelling in a west by north direction with a velocity of about 10 miles per hour. It was then of moderate size, but of great intensity. Hurricane winds blew at distances of at least 30 miles from the centre, and very strong winds (exceeding five times their normal force) at distances of 200 to 300 miles north of the centre. The barometer at the centre stood nearly an inch below its normal height.

The wind and barometric observations taken at 8 A.M. of the 1st show clearly that the centre of the storm was within the triangular area defined by the stations of Madras, Bangalore, and Cuddapah. Bangalore is 200 miles due west of Madras, and Cuddapah 150 miles to the north-west. The coast districts near Madras are very low to a distance of 40 or 50 miles from the sea coast, beyond which the ground rises rapidly and is more or less elevated and broken by hills. Bangalore is at an elevation of 2,150 feet in the midst of the Mysore plateau, and Cuddapah is situated in a valley at an elevation of about 450 feet amidst ranges of the East Ghâts of 1,500 to 2,000 feet in elevation.

The following gives the barometric and wind observations at these stations at 8 A.M. of the 1st :—

—	Barometer.	Variation from normal.	Wind direction.	Ratio of actual to normal wind velocity.
Madras	29·707	—·148	S.	457
Bangalore	29·849	+ ·008	N.-W.	125
Cuddapah*	29·777	—·060?	E. ?	...

The barometer at that hour was hence nearly a sixth of an inch higher at Bangalore than at Madras, and a twelfth of an inch higher at Cuddapah than at Madras. These facts taken in conjunction with the wind directions show that the centre of the cyclonic circulation (or cyclonic storm), which was still in existence, was to the west or west-north-west of Madras, and much nearer to that station than either to Bangalore or Cuddapah.

The following are the corresponding observations taken at 4 P.M :—

—	Barometer.	Variation from normal.	Wind direction.	Ratio of actual to normal wind velocity.
Madras	29·668	—·103	S.-S.-E.	3·14
Bangalore	29·711	—·030	N.-W.	2·75
Cuddapah	29·715	—·040?	E.?	...

Pressure was lowest at Madras as it had been at 8 A.M., but the differences between the pressure at that station and at Bangalore and Cuddapah were much smaller than at 8 A.M. This, taken in conjunction with the shift of wind at Madras from S. to S.-S.-E., indicates that the storm centre had advanced further to the west during the interval, but the pressure distribution establishes that it was nearer to Madras than to either Bangalore or Cuddapah. Taking into consideration the distances of these stations from Madras, it is certain that the storm centre had not advanced more than 70 miles to the west of Madras during the 18 hours extending from 10 P.M. of the 31st October to 4 P.M. of the 1st November, whilst the barometric data prove that the depression had filled up very largely (if not almost entirely) during that interval. This is further confirmed by the fact that the wind velocities at 4 P.M. were comparatively small, and were barely strong enough to be considered as stormy winds. The average velocity of the storm centre during the previous 18 hours was hence less than 4 miles per hour. As its velocity at the commencement of this interval (10 P. M. when crossing the coast) was at least 10 miles per hour, it is almost certain that its velocity during the afternoon of the 1st was less than 2 miles per hour, at which rate it would have required five or six days to cross the Peninsula in the latitude of Madras.

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* Observations have not been recorded at Cuddapah for a sufficient number of years to give accurate means.

The position of the storm centre has hence been traced up to 4 P.M. of the 1st November without any difficulty. At that time it was probably near Chittoor, and about 70 or 80 miles from the Madras coast, or near the foot of the hills bounding the Mysore plateau. The barometric depression in the storm area was now very small (probably less than a sixth of an inch), the winds were comparatively feeble (at Madras they averaged 14 miles per hour during the previous 8 hours, and at Bangalore 3 miles per hour); and the storm centre was almost stationary and advancing at a rate probably not exceeding 2 miles per hour. These facts show that the storm had almost filled up and was now of comparatively little importance. They also establish that the storm, which was a very intense one when it crossed the coast, had hardly any power of crossing hills. It was in fact evidently one of low elevation in which the cyclonic circulation is rapidly broken up by the obstruction of a line of hills running at right angles across the path of the storm.

Taking the whole of these facts into consideration the most reasonable inference is that the storm would completely fill up during the night of the 1st, and disappear before the morning of the 2nd.

We have now to ascertain whether this was really the case.

The observations of the next week show that a cyclonic storm crossed the Kattiawar coast on the morning of the 9th, and the simplest explanation of the origin of the storm is that it was the direct continuation of the storm which crossed the Madras coast on the evening of the 31st October.

In order to establish that this storm did not die out on the evening of the 1st, as appeared to be most probable from the observations of that day, it is necessary to establish that a depression which the 8 A.M. observations of the 2nd indicated as in existence off the Malabar coast near Mangalore was the continuation of the Madras storm. It was in fact the only depression in existence on the morning of the 2nd in the Southern Indian area.

Hence we have to enquire—

(*a*) Whether this depression was the continuation of the Madras cyclonic storm.

(*b*) Whether there was a cyclonic storm prevailing in this depression area.

The whole of the evidence given in pages 225-8 shows that the area of depression off the West coast was characterized by light variable winds and squally weather on the evening of the 2nd, but that there was no strong or well-defined cyclonic circulation of the winds. Hence it is certain that a cyclonic storm did not pass across the West Ghâts into the Arabian Sea on the morning of the 2nd. Also the following facts appear to establish that the Madras depression filled up on the evening of the 1st, and that the Arabian Sea depression was not, in the ordinary acceptation of the word, a cyclonic storm and the continuation of the Madras cyclone.

The first is that cyclonic storms and barometric depressions in October and November have very slight power of ascending and crossing hills and mountain districts, and in the great majority of cases they are either broken up or deflected northwards when they approach a line of hills running transversely to the direction of this path.

The following gives a list of all the cyclonic storms of October, November, and December in the Peninsula of the last five years, and their subsequent course after reaching land :—

1885.—Storm of 1st to 3rd November. Crossed the coast near Madras and broke up very shortly afterwards in the Carnatic.

1886.—Storm of 16th to 20th October. Crossed the coast near Cocanada and broke up without crossing the East Ghâts.

1886.—Cyclone of 2nd to 16th November. Crossed the Madras coast, and, so far as can be judged by the observations, passed out into the Arabian Sea, and advanced by a curved path to the Beluchistan coast.

1886.—Storm of 14th to 24th November. Crossed the Circars coast and filled up without crossing the East Ghâts.

1886.—Storm of 7th to 9th December. Crossed the coast near Madras, and broke up in the Peninsula.

1887.—Storm of 8th to 14th October. Crossed the coast near Madras, and recurved in the Peninsula first to north and then to north-east, and broke up in the North-West Provinces.

1888.—Cyclone of 24th October to 1st November, *viz.*, the storm under discussion.

1888.—Storm of 12th to 16th December. Crossed the coast south of Negapatam and broke up in South India.

1889.—Storm of 19th to 27th December. Crossed the Madras coast and broke up in South India.

Hence, of these nine storms only one apparently crossed the West Ghâts and was continued as a cyclonic storm in the Arabian Sea. Even this storm is doubtful, as in the report of it which was drawn up by myself and published in the Meteorological Memoirs, Volume IV, Part 4, it was noted that the method of its transmission across the Ghâts was not shown. Hence the chances based on previous experience against a cyclonic storm in November passing across the Peninsula into the Arabian Sea are at least 10 to 1. In the present case it has been shown that the storm had almost filled up on the 1st, and that it was almost stationary at that time and apparently unable to surmount the hills bounding the eastern edge of the Mysore plateau. Taking the latter facts into consideration, it increases the probabilities against the storm in question crossing the Peninsula to at least 100 to 1.

Again, the centre of the depression off the West Coast at Mangalore at 8 A.M. of the 2nd was at least 300 miles west of the position of the storm centre at 4 P.M. of the 1st. The 4 P.M. observations of the 2nd show that the very slight depression off Mangalore had disappeared, but that another was in existence off Karwar, the centre of which was at least 150 miles to the north-north-west of the centre of the depression in existence at 8 A.M.

If it be assumed that these depressions were the direct continuation of the depression and storm in Southern India on the 1st, and that the depression was propagated or advanced in the same manner in which a cyclonic storm is usually considered to be propagated, it would be necessary to assume that shortly after 4 P.M. of the 1st, when the storm was apparently dying out, its energy was suddenly and largely increased, so that it was enabled to move westwards across the Mysore plateau (average elevation 2,500 feet) and the West Ghâts in Mysore and Coorg (average elevation 5,000 feet) with a mean velocity of at least 20 miles per hour, and that after 8 A.M. of the 2nd it recurved and moved to the north-north-west with an average velocity even exceeding that of the previous night. There is not a single observation, so far as I can judge, which support sthis explanation, and the whole weight of fact and probability is opposed to it.

Having thus proved, so far as it is possible, that the depression off Mangalore on the 2nd was not the continuation of the Madras storm in the proper sense of the word, it remains to give some explanation of the formation of that depression. It has been pointed out that although the phenomena indicate that the cyclonic circulation broke up as a cyclonic storm, they also suggest that a disturbance was propagated westwards which was probably absorbed into an area of unsettled weather in the Arabian Sea on the 2nd and 3rd.

It is hence necessary to indicate the physical actions which might produce such an effect in order to show that the explanation is not only a possible but a probable one.

The cyclone when it crossed the Madras coast was one of comparatively low elevation. In other words, the ascensional movement and the condensation of aqueous vapour were most vigorous at a very moderate elevation, probably not exceeding 3,000 feet. The ascensional movement determined by this condensation of aqueous vapour and transfer of energy was necessarily continued upwards to a considerable elevation above the region of most vigorous action, and gave rise to an anticyclonic outflow in the upper strata. Whilst the cyclone was advancing across the sea area to the coast, these two parts of the complete cyclonic circulation formed a single system, the motion of the upper portion being evidently determined by that of the lower portion. When the cyclone crossed the coast, it was approaching the line of the East Ghâts, a range of hills, the average elevation of which in the Carnatic is about 2,000 feet. This line of hills ran almost directly across the path of the storm, and hence offered a very powerful obstacle to the easterly humid winds feeding into the storm. Hence the lower cyclonic circulation was broken up in the course of a few hours. The humid winds no longer fed into the storm area as heretofore, and the rain instead of being concentrated and cyclonic in character, became diffused and irregular in its distribution. Hence not only was the lower air circulation broken up, but the transfer of energy necessary to maintain the active ascensional movement and cyclonic phenomena in the lower air strata ceased. The dependent movement in the higher strata, which had been initiated and controlled by this lower air motion, was not affected by any obstacle. As the viscosity or frictional resistance of the upper strata of the air to motion is small in amount, the motion in the higher strata would hence continue for a very considerable period after the breaking up of the lower air motion, and the mass under consideration would move forward as an eddy in the middle strata of the atmosphere, and hence probably with a velocity not very different from that of the strata in which it was embedded. The average motion of such eddies in India appears to be about 15 miles per hour, or 300 to 400 miles per diem, which is the mean rate of motion of the larger cold weather storms across Northern India in the months of December, January, and February.

Hence, there appear to be sufficient theoretical reasons for believing that when such a storm as the Madras cyclone of October 31st crosses the coast, the cyclonic circulation in the lower atmospheric strata is generally, if not always, broken up by the obstructive action of the lines of hills in Southern India, and hence the cyclone or cyclonic storm only affects the coast districts. On the other hand, the upper portion of the cyclonic circulation breaks up very slowly, and, as it is no longer controlled by the indraught to the lower strata, it is carried forward with a velocity determined mainly by the movement of the middle atmospheric strata. Hence cloudy weather extends rapidly westwards, and the slight disturbance passes unaffected across the comparatively low West Ghâts, and may give rise to a slight depression in the Arabian Sea, where, if circumstances are favourable, this depression may develop again into a cyclonic storm or cyclone.

Numerous examples might be given of the apparent rapid transmission of slightly disturbed weather and of shallow depressions westwards across the West Ghâts into the Arabian Sea on the apparent breaking up of cyclones or cyclonic storms in Southern India in the months of October, November, and December from the weather charts published during the past three years. The following remarks in Mr. Blanford's report on the Meteorology of India for the year 1881 show that this peculiar feature of the cyclones of Southern India had not escaped his observation. He says:—

"On the 10th and 11th of November a small cyclone formed off the coast of Ceylon, and, on the morning of the 13th, reached the Madras coast, between Negapatam and Madras, moving apparently in a north-north-west direction. The barometric depression was small, but the winds were very strong, and the sea high; and, as aconseq uence, the Madras break-water, which had withstood, without injury, a previous cyclone of much greater barometric intensity, was greatly damaged. This vortex appears to have broken up against the Eastern Ghâts; but while it was still in existence a little to the west of Madras, another vortex was forming on the west coast south of Goa, and this appears to have pursued a north-west or west-north-west course across the Arabian Sea. The instance is important as illustrating what is most probably the usual history of such storms. It is doubtful if, in any case, a vortex crosses the plateau of the Peninsula at an elevation of between 2,000 and 3,000 feet above sea-level. Certainly there is no case of the kind on record since the weather phenomena have been laid down on daily charts."

American meteorologists appear to observe similar phenomena in the case of cyclonic storms approaching the Rocky Mountains. The Chief Signal Officer of the United States says of these storms: "When storms are said to cross the Rocky Mountains or other plateaux, it is, I believe, understood that it is an abridgment of a fuller statement of the process by which a disturbance on one side gives rise to a disturbance on the other *without the experience of an actual storm in the plateau.* Barometric, and sometimes thermometric, disturbances are apparently thus propagated without special rainfall or wind at the higher levels, but the subject is one which is still in need of further elucidation."

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III.—Discussion of the more important feature of the Third Storm.

Origin of the Third Storm.—The materials for the discussion of this storm are much less satisfactory from every point of view than of the preceding. They are much less in amount, as the storm proper did not advance across the usual steamer track between Bombay and Aden, and hence not more than one or two vessels were involved within the inner storm area. Much of the information is unsatisfactory, and in some cases is not only doubtful but almost certainly erroneous, and hence it was not possible to utilize it in the discussion of the storm.

The origin of the storm has been partly stated in the preceding pages. During the last week of October, when the previous cyclone formed in the Bay of Bengal and advanced westwards, weather was very disturbed over a large portion of the Arabian Sea. A steady north-east monsoon was blowing in the north of the Arabian Sea, and moderately strong south-west winds (due to the retreating south-west monsoon current) prevailed in the south. Between these two areas of opposite winds there was an intermediate area of low pressure, variable and unsteady winds, frequent rain squalls and unsettled weather. This area formed a long and comparatively narrow belt or trough which stretched from about the meridian of 54° E. to that of 68° E., and between the parallels of 12° and 16° N. So far as can be judged from the limited information, there was a tendency to the formation of cyclonic whirls in this area, but they did not pass beyond the initial stage. The Peninsular and Oriental steamer *Clyde* prepared for bad weather on the 1st when entering this area on her passage from Aden to Bombay. The S.S. *Serapis* had north-east gales, force 8, on the same day. The ship *Columbus* encountered stormy weather in this area on the 31st and 1st. This disturbance was evidently independent of the cyclonic storm in the Bay of Bengal, and different in character. It was a diffused disturbance spread out over a large area in which a tendency to concentration showed itself in different parts for short periods, but passed away. When the cyclone, which had formed in the Bay of Bengal, passed across the Madras coast, it filled up rapidly and broke up as a cyclonic storm on the frontiers of Madras and Mysore. The disturbance in the middle (and upper?) atmospheric strata due to the cyclone was, however, not only continued, but was carried rapidly to the westwards with a velocity of 300 to 400 miles per diem. This slight disturbance passed out into the Arabian Sea on the morning of the 2nd, and was apparently absorbed shortly afterwards on the 3rd or 4th into the eastern portion of the area of unsettled weather which had been in existence in the Arabian Sea for some days. The weather gradually improved in the western half of this intermediate area, but it became very disturbed in the eastern half, more especially near the eastern extremity.

The area of disturbed squally weather shifted and extended slightly during the 4th, 5th, and 6th, without showing any definite centre, or concentration of wind or rain such as marks the initial stage of a cyclonic storm. On the night of the 6th and the 7th it concentrated and began to move to the north-north-east. The S.S. *Idar* was involved in the storm on the 8th, and experienced hurricane winds. It was then a small but severe cyclonic storm, and advancing towards the Kattiawar coast which it crossed next morning (the 9th) about 8-30 A.M.

Character of the Storm.—The storm derived an unusual interest from the fact that the *Vaiturna* coasting steamer, with 600 native passengers on board, went down in the storm during the night of the 8th. She was, however, a very light vessel of small draught and with much top-hamper, and hence not fitted to encounter a cyclonic storm.

The whole of the evidence appears to show that although very strong (probably hurricane) winds prevailed near the centre of the storm, it was an unusually small cyclone. The only vessel contributing information which passed through it was the S.S. *Idar*. She was involved in it on the evening of the 7th and morning of the 8th, and was evidently carried with the storm by the currents for several hours, as her barometer was almost unchanged in height from 4 A.M. to noon of the 8th (being about half an inch below the normal). Her observations hence do not enable any estimate of the storm area to be made.

There were several steamers off the Kattiawar coast on the steamer track between Kurrachee and Bombay on the night of the 8th and morning of the 9th. The following table gives the position of these vessels at 8 A.M. of the 9th, when the storm centre was approaching the coast nearly midway between Verawal and Mangrol, and was at a distance of 5 to 10 miles from that coast:—

VESSEL.	Distance and bearing of vessel from centre.	BAROMETER.		Wind direction.	WEATHER.
		Actual.	Corrected.		
Pachumba . .	15 miles south.	29·76	29·76	S.-S-E.	Strong gale and high cross sea and heavy squalls.
Hampstead . .	75 miles to S.-E. by E.	·24	29·79	S.	Strong wind and heavy sea.
Purulia . .	95 miles to S.-E. by E.	·88	29·82	S.	Moderate to fresh gale, with frequent heavy rain squalls.
Idar . . .	120 miles S.-S.-E.	·62	29·81?	S.-S.-W.	Fresh breeze; sea comparatively smooth.
Calder . . .	40 miles S.-S.-W.	·78	29·78	N.-W. to W. (?)	Moderate gale with high confused sea.

The preceding observations establish completely that the storm was of very small extent. The *Pachumba* was only 18 miles south of the centre, and in the quadrant of strongest winds. Her barometer had fallen very slightly since leaving Bombay, and was only about a sixth of an inch below the normal; hence the depression at a distance of less than 20 miles from the centre was only a fifteenth of that observed at False Point in the September cyclone of 1885, and a sixth of that at Madras when the second storm discussed in this memoir passed over it. The *Pachumba* at that time experienced a strong gale with heavy squalls. When this is compared with the winds experienced by the *Sirsa* and *Bhandara* in the Bay of Bengal a week previously, at much greater distances from the centre in the second cyclone in the Bay, the small extent and feebleness of the storm as compared with the previous storm, become apparent.

The remaining four vessels were at distances varying from 40 to 130 miles. The *Purulia* crossed in front of the storm on her voyage from Kurrachee to Bombay, and the *Calder* crossed the track about 30 miles behind the centre. These vessels reported moderate breezes to a moderate gale. The logs of these vessels for the 8th and 9th are given in Appendix C. A reference to them will show that in no case did the barometer fall to any extent, or indicate that the vessels were passing through or near a severe cyclonic storm. So far as can be judged from the data, the diameter of the storm area, in which winds of force 8 or upwards prevailed, does not appear to have exceeded 70 or 80 miles. Outside this area the winds were by no means strong, and within this area they were apparently nowhere of hurricane force.

It is hence very probable that this storm, which formed on the 6th and 7th in the eastern part of the intermediate area of low pressure and squally weather in the Arabian Sea, was of very small extent, and that the diameter of the area in which the winds were of force 8 was certainly less than 80 miles and probably less than 60 miles. The barometric depression was also, so far as can be judged, very small, and probably never exceeded four or five tenths of an inch at the centre.

Track of the Storm.—The following table gives the position of the centre at various dates, beginning with the noon of the 7th when the storm had formed and was beginning to move northwards:—

Day.	Hour.	Position of Centre.			Distance passed over in previous hours.	Rate of motion per hour.
			Latitude, N.	Longitude, E.		
			°	° '		
7th . .	Noon .	...	16 0	67 30	...	...
8th . .	8 A.M. .	...	17 45	68 30	180	9 miles.
9th . .	8 A.M. or 8-30 A.M.	Crossed the coast midway between Mangrol and Verawal.	21 0	70 30	240	10 miles.
9th . .	4 P.M. .	Between Bhuj and Rajkot and near to Rajkot.	22 30	71 0	88	11 miles.
10th . .	8 A.M. .	...	23 15	71 30	84	5½ miles.

The discussion has shown that the unsettled squally weather off the Bombay coast did not develop into a cyclonic storm until the 6th and 7th, and hence that there was no well-defined centre of cyclonic circulation until the 7th. The storm marched to the north by east, at an average rate of about 10 miles until it reached the Kattiawar coast. It broke up as a cyclonic storm about 24 hours afterwards in the neighbourhood of the Aravalli Hills, and its velocity decreased considerably during the last 12 or 18 hours of its existence.

Barometric depression.—The following table gives the data from which the pression at and near the centre of the storm can be estimated :—

Day.	Hour.	Ship or place of observation.	Position.		Barometer corrected.	Variation from normal	Distance and bearing of centre.	Weather at place of observation.
			Latitude, N.	Longitude, E.				
			° ′	° ′	″	″	Miles.	
	4 P.M.	S. S. *Columbus*	14 50	66 30	29·60	—·30	75 N.-E.	Hurricane.
	Noon	S. S. *Drumbarlie*	17 53	69 4	29·69	—·31	150 S.-S.-W.	Heavy squalls.
	Noon	S. S. *Columbus*	15 14	67 23	29·68	—·28	80 N.-E.	Moderate gale.
	Noon	*Ditto*	15 39	68 28	29·78	—·18	70 W.-N.-W.	
	Noon	S. S. *Idar*	17 31	66 2	29·78	—·26	150 S.-E.	Fresh gale.
	Midnight.	*Ditto*	18 15	67 .0	29·43	—·59	30 S.	Hard gale.
	8 A.M.	*Ditto*	17 50	68 15	29·38	—·65	30 S.-E.	Cyclonic gale.
	„	Rajkot	22 17	17 52	29·84	—·19	90 S.	
h	„	Ditto	Do.	Do.	29·93	—·07	80 N.-E.	
	„	Deesa	24 16	72 14	29·92	—·09	75 S.-W.	

IV.—General Conclusions.

The following appear to be a few of the more important inferences with re-rd to the constitution and motion of the cyclonic storms described in the ceding pages, and, therefore, probably of cyclones generally in the Indian a :—

1st.—That the winds differ considerably in intensity in different quadrants, and that this difference is mainly caused by the fact that the humid winds which maintain the vigorous circulation of the cyclone enter mainly in one quadrant.

2nd.—The amount of ascensional movement or uptake differs very considerably in different quadrants, and is usually most rapid and vigorous in the advancing quadrant at some little distance in front of the centre.

3rd.—In consequence of ascensional motion and rainfall taking place most vigorously in the advancing quadrant, or in front of the cyclone, the isobars are oval in form, and the longest diameter coincides approximately with the direction of the path of the centre. The centre of the cyclonic circulation and of the storm is not in the middle of this diameter, but is at some distance behind. As a further consequence, the gradients are steepest in the rear of the storm centre.

4th.—A consideration of the relations stated in the preceding, show that a cyclonic circulation cannot be resolved into the translation of a rotating disc or mass of air. The fact that the main supply of the energy is applied in front of the cyclone suggests that it is perpetually renewed in front, and that in fact its motion and transmission are hence rather to be explained by some process analogous to the transmission of a wave.

5th.—The direction or line of advance of these storms appears to be mainly determined by the rainfall distribution. There is a very marked tendency for storms to form in and to run along the south-west monsoon trough of low pressure, if it be in existence at the time of the formation of the storm.

6th.—The lie of the south-west monsoon trough of low pressure at any time, and hence also of the most probable tracks of cyclonic storms at that time, depends upon the relative strengths and extension of the two currents. When both are blowing strongly, as is usually the case in July and August, the most probable direction of motion of a cyclonic storm at such a time is west with a slight curving to north, if the storm continues its course westwards after passing into the Central Provinces. If the Bombay current be weak, the storm will probably either break up in the Central Provinces or recurve rapidly to north.

APPENDIX A.

The following tables give complete rainfall data for all districts in the Central Provinces, North-Western Provinces and Oudh, and the Punjab, during the period of the storm of September. The distribution of rainfall is given in the four charts in Plates XXVII to XXVIII, in which the distribution of rainfall during the 24 hours preceding 8 A.M. of the date named in the charts is shown by means of lines of equal rainfall or isohyetic lines :—

Rainfall, Central Provinces, September 1888.

District.	16th September.			17th September.			18th September.			19th September.			Average total rainfall from 16th to 19th September.
	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	
Saugor	0·38	1·38	0·03	1·36	4·43	0·08	2·04	3·68	0·71	1·25	3·39	0·50	5·03
Damoh	0·31	0·87	0·06	0·32	0·85	0·10	0·39	0·96	0·20	0·17	0·50	0·50	1·19
Jubbulpore	0·35	0·77	0·11	0·45	0·64	0·20	0·36	0·62	0·22	0·19	0·60	0·04	1·35
Mandla	0·55	0·80	0·15	0·35	0·80	0·06	0·12	0·30	0·06	0·08	0·15	0·10	1·10
Seoni	0·39	0·57	0·25	2·32	3·65	1·32	1·52	1·80	1·10	0·46	0·63	0·24	4·69
Narsinghpur	0·57	0·78	0·30	0·76	1·35	0·40	1·00	1·43	0·70	0·19	0·58	0·58	2·52
Hoshangabad	0·44	1·05	0·02	1·94	4·00	0·14	2·71	6·38	0·60	2·10	2·50	1·51	7·19
Nimar	...	...	...	0·48	1·33	0·12	1·62	2·58	1·14	0·96	2·29	0·18	3·06
Betul	0·27	0·60	0·46	2·77	6·22	0·85	5·25	9·29	1·60	0·64	1·90	0·64	8·93
Chhindwara	0·38	0·63	0·12	1·37	1·92	0·81	2·29	2·30	2·27	0·41	0·41	0·40	6·45
Wardha	0·05	0·15	0·15	0·59	0·88	0·30	1·14	2·62	0·10	...	...	...	1·78
Nagpur	0·12	0·33	0·04	1·37	1·90	0·57	2·74	8·40	0·69	0·34	0·65	0·22	4·57
Chanda	0·41	1·90	0·04	1·41	3·10	0·60	0·19	0·40	0·09	0·11	0·26	0·02	2·12
Bhandara	1·17	3·50	3·50	2·86	3·50	1·78	0·84	1·25	0·25	...	...	...	4·87
Balaghat	...	0·01	0·01	2·10	2·52	1·59	0·64	1·07	0·15	0·17	0·32	0·20	2·91
Raipur	0·38	1·05	0·22	2·13	3·50	0·97	0·02	0·07	0·07	0·01	0·03	0·03	2·54
Bilaspur	0·16	0·95	0·95	0·36	1·57	0·61	0·24	0·47	0·47	0·73	1·18	0·27	1·49
Sambalpur	1·05	1·36	0·42	0·41	1·05	0·04	0·55	1·15	0·20	0·10	0·20	0·06	2·11
Kalahandi State	2·23	2·23	2·23	1·00	1·00	1·00	...	...	...	0·07	0·07	0·07	3·30
Bastar State	1·70	1·70	1·70	0·14	0·14	0·14	0·15	0·15	0·15	0·23	0·23	0·23	2·22

Rainfall, North-Western Provinces, September 1888.

District.	16th September.			17th September.			18th September.			19th September.			20th September.			Average total rainfall from 16th to 20th September.
	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	
Dehra Dun	...	...	...	0·05	0·27	0·05	0·45	1·00	0·08	2·18	2·72	1·71	3·33	4·65	1·80	6·01
Saharanpur	...	...	...	...	...	...	1·90	5·43	0·90	4·30	8·20	2·50	6·51	9·50	1·50	12·71
Muzaffarnagar.	...	...	...	0·15	0·60	0·30	2·78	3·80	1·65	4·62	6·90	2·30	3·90	6·00	0·60	11·45
Meerut	...	...	...	0·29	2·00	2·00	1·73	3·20	0·90	2·79	5·30	1·00	3·19	4·55	2·20	8·00
Bulandshar	...	..	...	0·08	0·50	0·50	2·56	5·50	1·00	5·32	6·40	3·90	2·17	3·50	1·30	10·13
Alibagh	...	...	...	0·69	1·90	0·35	1·55	2·40	0·50	4·65	7·00	2·50	1·29	1·70	0·60	8·18
Bijnor	...	...	...	...	...	...	3·58	4·10	2·90	2·70	3·50	1·30	4·00	4·72	3·60	10·28
Moradabad	...	...	...	0·80	2·90	0·40	2·16	3·90	1·20	2·01	2·30	1·37	2·89	5·10	1·45	7·86
Pilibhit	...	...	...	2·50	3·30	1·30	0·51	0·70	0·30	1·12	1·80	0·50	2·27	3·30	0·90	6·40

Rainfall, North-Western Provinces—continued.

DISTRICT.	16TH SEPTEMBER.			17TH SEPTEMBER.			18TH SEPTEMBER.			19TH SEPTEMBER.			20TH SEPTEMBER.			Average total rainfall from 16th to 20th September.
	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	
Bareilly	...	...	...	2·11	2·50	1·40	0·70	1·20	0·20	2·07	2·78	0·90	1·79	5·40	0·32	6·67
Budaun	0·02	0·10	0·10	1·65	2·73	0·50	1·20	2·40	0·20	3·16	5·90	1·30	1·07	3·00	0·20	7·10
Shajahanpur	...	...	...	0·53	1·20	0·12	0·44	0·74	0·10	0·91	1·30	0·30	0·99	2·30	0·40	2·87
Muttra	0·16	0·50	0·48	0·68	1·10	0·70	1·05	3·10	0·40	3·26	4·70	0·65	0·21	0·90	0·07	5·36
Agra	0·25	1·20	0·27	1·48	6·08	0·20	2·01	4·80	0·90	6·06	9·00	4·23	1·08	3·70	0·34	10·88
Mainpuri	0·30	2·00	0·10	0·58	2·80	0·20	0·39	1·00	0·30	2·30	4·00	1·30	0·41	1·40	0·07	3·98
Furruckabad	...	...	...	0·20	0·75	0·12	0·31	0·53	0·26	1·50	2·56	0·74	0·03	0·17	0·17	2·04
Etawah	0·07	0·30	0·04	0·49	1·30	0·05	0·24	0·42	0·10	0·77	0·93	0·60	0·14	0·60	0·10	1·71
Etah	...	...	...	2·63	3·80	1·10	2·05	3·60	1·40	2·81	5·00	1·10	0·63	1·30	0·40	8·12
Cawnpore	0·14	1·10	0·06	0·12	0·78	0·04	0·48	1·10	0·14	0·68	2·00	0·20	...	...	...	1·42
Fatehpur	0·11	0·40	0·10	0·10	0·40	0·20	0·72	1·50	0·60	0·26	0·60	0·30	0·14	0·40	0·02	1·33
Banda	0·26	0·57	0·14	1·09	3·61	0·06	1·74	5·60	0·20	0·08	0·36	0·08	0·02	0·15	0·15	3·19
Allahabad	0·40	1·60	0·20	0·19	0·50	0·14	0·36	1·00	0·20	0·27	0·80	0·10	0·14	0·40	0·20	1·36
Hamirpur	0·16	0·43	0·12	0·77	1·20	0·35	2·14	3·12	0·98	0·89	2·70	0·40	...	...	...	3·96
Jaunpur	0·14	0·50	0·10	0·61	1·20	0·10	0·16	0·60	0·10	2·00	3·00	1·22	...	...	...	2·91
Azamgarh	0·09	0·40	0·06	0·06	0·30	0·30	0·24	0·50	0·20	0·43	1·07	0·20	0·96	2·00	0·80	1·78
Mirzapur	0·16	0·73	0·01	0·44	0·85	0·44	0·02	0·07	0·05	0·40	0·66	0·11	0·13	0·27	0·04	1·15
Benares	0·20	0·30	0·10	0·27	0·80	0·80	...	...	...	0·23	0·40	0·30	0·58	0·90	0·85	1·28
Gorakhpur	...	...	...	0·19	0·70	0·10	0·69	1·50	0·15	0·03	0·20	0·20	0·90	1·60	0·20	1·81
Basti	...	...	...	0·21	0·40	...	0·57	1·00	0·30	0·08	0·20	...	0·75	1·03	...	1·61
Ghazipur	0·11	0·20	0·05	0·08	0·30	0·30	0·25	0·70	0·10	0·78	1·30	0·40	0·99	1·67	1·10	2·21
Ballia	0·30	0·60	0·60	0·21	0·21	0·20	0·10	0·20	0·20	...	...	...	0·40	0·60	0·20	1·01
Jalaun	0·28	1·20	0·10	0·84	1·90	0·20	0·94	2·50	0·40	1·54	2·70	1·40	...	...	...	3·60
Jhansi	0·91	1·90	0·04	1·26	2·50	0·50	1·13	2·00	0·20	0·71	3·10	0·10	...	...	...	4·01
Lalitpur	0·52	0·90	0·28	1·75	2·30	1·28	0·84	1·10	0·70	0·40	0·50	0·20	...	...	...	3·51
Kumaun	0·14	0·40	...	1·03	3·10	0·03	4·51	13·40	1·80	3·43	5·80	2·00	1·56	3·30	0·30	10·67
Garhwal	0·26	1·02	...	0·15	0·48	...	2·30	3·50	1·30	1·56	2·37	0·95	0·48	1·25	0·05	4·75
Tarai	...	...	...	1·95	3·50	...	0·78	1·40	0·30	1·90	2·40	1·50	2·33	3·52	1·60	6·95

Rainfall, Oudh, September 1888.

DISTRICT.	16TH SEPTEMBER.			17TH SEPTEMBER.			18TH SEPTEMBER.			19TH SEPTEMBER.			20TH SEPTEMBER.			Average total rainfall from 16th to 20th September.
	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	
Lucknow	1·03	2·50	0·60	0·09	0·13	0·13	0·13	0·23	0·16	0·71	1·27	0·87	0·82	1·50	0·96	2·78
Unao	...	...	...	0·38	0·50	0·20	0·20	0·30	0·10	1·60	2·60	1·00	0·65	1·60	1·00	2·83
Bara Banki	...	...	...	0·11	0·20	0·10	0·43	1·20	0·10	0·50	0·80	0·40	1·66	2·20	1·20	2·70
Sitapur	...	...	...	0·08	0·30	0·30	0·67	1·80	0·40	0·11	0·30	0·14	0·49	0·80	0·50	1·35
Hardoi	0·06	0·25	0·25	0·13	0·52	0·52	0·22	0·60	0·27	1·38	2·70	0·40	1·46	3·95	0·54	3·25
Kheri	...	...	...	1·03	2·50	0·20	0·20	0·62	0·62	1·22	3·20	0·20	0·87	1·70	0·90	3·32
Fyzabad	0·09	0·37	0·37	0·07	0·28	0·28	0·73	0·90	0·60	0·25	0·90	0·10	1·65	2·30	0·60	2·79
Bahraich	...	...	...	0·07	0·21	0·21	0·97	1·61	0·61	0·18	0·34	0·08	0·74	1·28	0·95	1·96
Gonda	...	...	...	0·33	0·80	0·20	0·67	1·40	0·22	0·55	1·50	0·05	0·81	1·00	0·50	2·36
Rae Bareilly	0·30	0·80	0·41	0·10	0·30	0·11	0·31	0·50	0·15	1·66	2·20	0·42	0·39	0·65	0·29	2·76
Sultanpur	0·33	0·60	0·30	0·05	0·20	0·20	0·38	1·00	0·20	0·56	1·40	0·10	2·52	5·00	0·66	3·84
Partabgarh	0·02	0·05	0·05	0·77	2·30	0·02	0·68	1·00	0·35	0·90	1·60	0·20	0·33	1·00	1·00	2·70

Rainfall, Punjab, September 1888.

DISTRICT.	18TH SEPTEMBER.			19TH SEPTEMBER.			20TH SEPTEMBER.			21ST SEPTEMBER.			Average total rainfall from 18th to 21st September.
	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	Average rainfall of district.	Heaviest rainfall in district.	Least rainfall in district.	
Hissar	...	...	...	1·8	3·0	0·5	0·9	2·0	0·1	...	...	...	2·70
Rohtak	0·2	0·4	0·3	3·4	5·6	2·1	1·4	2·5	1·0	0·1	0·2	0·2	5·10
Gurgaon	1·2	3·0	0·1	3·4	6·8	0·6	0·4	1·5	0·1	...	0·2	0·2	5·00
Delhi	1·9	3·9	1·0	4·4	5·9	2·4	3·3	5·8	2·2	0·1	0·6	0·6	9·70
Karnal	...	...	...	2·1	4·1	1·0	3·2	5·9	1·6	0·3	1·1	0·3	5·60
Umballa	...	...	...	3·0	6·6	1·4	7·9	10·3	3·4	1·0	3·2	0·1	11·90
Simla	0·2	0·5	0·5	3·9	5·5	1·8	5·0	9·5	1·4	...	...	...	9·10
Kangra	...	...	...	1·0	3·3	0·2	1·7	3·3	1·0	1·0	5·5	0·1	3·70
Hoshiarpur	...	...	...	1·1	2·4	0·6	1·8	4·4	1·4	0·2	0·7	0·1	3·10
Jullunder	...	...	...	1·6	2·6	0·7	2·3	5·7	0·4	0·3	1·0	0·1	4·20
Ludhiana	...	...	...	2·7	3·3	1·7	3·8	9·0	0·1	0·7	1·9	0·2	7·20
Ferozepur	...	...	...	0·2	1·0	0·1	0·3	0·6	0·3	...	...	...	0·50
Mooltan	*Nil.*												
Jhang													
Montgomery													
Lahore													
Amritsar													
Gurdaspur													
Sialkot													
Gujrat													
Gujranwalla													
Shahpur													
Jhelum													
Rawalpindi													
Hazara													
Peshawar													
Kohat													
Bannu													
Dera Ismail Khan.													
Dera Ghazi Khan.													
Muzaffargarh													

APPENDIX B.

Log of H. M. I. M. S. "Clive."

Date.	Hour.	Height of		Wind.		Weather.
		Barometer.	Thermometer.	Direction.	Force.	
30th October .	4 A.M.	29·91	78	N.	4	Overcast squally weather with passin showers. Lightning.
,, ,, .	8 A.M.	29·92	78	N.	2	Continued rain.
,, ,, .	1 P.M.	29·90	76			
,, ,, .	2 P.M.	29·90	...			
,, ,, .	4 P.M.	29·88	75	N.-W.	3	Weather threatening, with hard squall and much rain throughout.
,, ,, .	6 P.M.	29·84	75			
,, ,, .	8 P.M.	29·86	74	N.-W.	6	Squally weather. Continued rain.
,, ,, .	10 P.M.	29·87	78			
,, ,, .	11 P.M.	29·86	78			
,, ,, .	Midnight.	29·82	78	N.-W.	7	Threatening appearance. Low cumulus scud, and hard squalls with rain.
31st October .	1 A.M.	29·80	...	W.-N.-W.		
,, ,, .	2 A.M.	29·78	...	W.-N.-W.	...	Very hard squalls at intervals.
,, ,, .	3 A.M.	29·75	...	N.-W.		
,, ,, .	3-30 A.M.	29·74	...			
,, ,, .	4 A.M.	29·74	...	N.-W.	6	Squally weather with continuous rain.
,, ,, .	4-30 A.M.	29·73	...			
,, ,, .	5 A.M.	29·73	...	N.-W.	...	Moderate sea and hard squalls and rain throughout.
,, ,, .	5-30 A.M.	29·76	...			
,, ,, .	6 A.M.	29·78	...	N.-W. by W.	8	Squally rainy weather.
,, ,, .	6-30 A.M.	29·78	...			
,, ,, .	7 A.M.	29·78	...	N.-W. by W.		
,, ,, .	8 A.M.	29·80	...	N. by W.	8	Same weather as at 6 A.M.
,, ,, .	8-30 A.M.	29·80	...			
,, ,, .	9 A.M.	29·80	...	N. by W.		
,, ,, .	9-30 A.M.	29·79	...	...		
,, ,, .	10 A.M.	29·78	...	N. by W	...	Masses of cumulus scud flying at low altitudes from north-west.
,, ,, .	10-30 A.M.	29·76	...	...	...	
,, ,, .	11 A.M.	29·74	...	N.-W. by W.		
,, ,, .	11-30 A.M.	29·71	...	...		
,, ,, .	Noon	29·71	...	N.-W. by W.	8	Squally rainy weather.
,, ,, .	0-30 P.M.	29·68	...	N.-W. by W.	...	Wind increasing in violence with high cross north-easterly sea.
,, ,, .	1 P.M.	29·64	...	W. by N.		
,, ,, .	1-30 P.M.	29·62	...	N.-N.-W.	10	
,, ,, .	2 P.M.	29·57	...	W.-N.-W.		
,, ,, .	2-30 P.M.	29·54	...	West	...	Whole gale from west-north-west wit violent squalls and incessant blindin rain. High confused north-easterly sea.
,, ,, .	3 P.M.	29·48	...	W. by N.		
,, ,, .	3-30 P.M.	29·49	...	W. by S.		
,, ,, .	4 P.M.	29·37	78	W.-S.-W.		
,, ,, .	4-15 P.M.	29·36	...	...	...	Heavy confused sea.
,, ,, .	4-30 P.M.	29·36	...	W.-N.-W.	11	
,, ,, .	4-45 P.M.	29·37	...	...	...	Squally weather with continuous rai and lightning.
,, ,, .	5 P.M.	29·41	...	West	10	
,, ,, .	5-15 P.M.	29·33	...	...	...	
,, ,, .	5-30 P.M.	29·26	...	S.-W. by W.	12	

Log of H. M. I. M. S. "Clive"—continued.

Date.	Hour.	Height of		Wind.		Weather.
		Barometer.	Thermometer.	Direction.	Force.	
31st October	5-45 P.M.	29·25	...	...	...	Heavy beam sea; blinding rain blowing a fresh cyclone.
,, ,,	5-55 P.M.	...	...	...	...	Lull for 10 minutes, and again increasing to hurricane violence.
,, ,,	6 P.M.	29·24	...	S.-W. by W.	...	Lightning.
,, ,,	6-15 P.M.	29·49	...	...	...	
,, ,,	6-30 P.M.	29·57	...	S.-W. by W.	9	
,, ,,	6-45 P.M.	29·58	...	...	...	
,, ,,	7 P.M.	29·60	...	S.-W. by W.	...	
,, ,,	7-15 P.M.	29·62	...	...	...	
,, ,,	7-30 P.M.	29·64	...	S.-W. by W.	9	
,, ,,	7-45 P.M.	29·65	...	...	...	
,, ,,	8 P.M.	29·67	78	S.-W. by W.	...	Squally rainy weather with lightning.
,, ,,	8-30 P.M.	29·69	...	S.-W. by W.	9	Weather moderating. Barometer rising.
,, ,,	9 P.M.	29·73	...	S.-W. by W.	...	
,, ,,	9-30 P.M.	29·74	...	South.	7	
,, ,,	10 P.M.	29·75	...	South.	...	Vivid lightning to the southward; overcast gloomy weather, with drizzling rain throughout.
,, ,,	10-30 P.M.	29·77	...	S.-E.	...	
,, ,,	11 P.M.	29·77	...	S.-E.	...	
,, ,,	11-30 P.M.	29·77	...	S.-E.	...	
,, ,,	Midnight	29·77	79	S.-E.	...	Same weather as at 10 P.M.
1st November	0-30 A.M.	29·77	...	...	...	Squalls and lightning from south-east.
,, ,,	1 A.M.	29·77	...	S.-S.-E.	5	
,, ,,	1-30 A.M.	29·77	...	...	...	
,, ,,	2 A.M.	29·78	...	E.-S.-E.	...	Squally rainy weather.
,, ,,	2-30 A.M.	29·77	...	...	...	Hard squall from south-east, accompanied by lightning and rain.
,, ,,	3 A.M.	29·77	...	S.-E. by E.	...	Continuous drizzling rain and heavy confused sea, with south-south-east swell.
,, ,,	3-30 A.M.	29·78	...	...	...	
,, ,,	4 A.M.	29·79	80	E.-S.-E.	5	Overcast with rain.
,, ,,	4-30 A.M.	29·79	...	...	...	
,, ,,	5 A.M.	29·79	...	S.-E.	...	Dense bank of cumulus cloud to the westward about 20° of altitude.
,, ,,	5-30 A.M.	29·79	...	...	...	Weather breaking to the south-eastward. Blue sky in that quarter.
,, ,,	5-55 A.M.	...	...	...	...	Confused south-westerly swell.
,, ,,	6 A.M.	29·79	...	S.-E.	...	Partially clouded blue sky.
,, ,,	6-30 A.M.	29·79	...	..	...	
,, ,,	7 A.M.	29·80	...	S.	...	Moderate squall from southward, shifting to south-south-west.
,, ,,	7-30 A.M.	29·82	...	S.-S.-W.	...	
,, ,,	8 A.M.	29·83	82	S. by W.	5	Cloudy.
,, ,,	8-30 A.M.	29·83	...	...	...	
,, ,,	9 A.M.	29·85	...	S. by W.	...	
,, ,,	9-30 A.M.	29·88	...	...	...	
,, ,,	10 A.M.	29·90	...	S. by W.	...	
,, ,,	10-30 A.M.	29·91	...	...	...	Heavy swell from south-east; weather dry and bright.
,, ,,	11 A.M.	29·93	...	S. by E.	...	
,, ,,	11-30 A.M.	29·93	...	...	...	
,, ,,	Noon.	29·93	84	S.-E. by S.	5	Fresh breeze. Heavy bank of cumulus cloud to west by north; moderate south-easterly swell.
,, ,,	0-30 P.M.	29·87	...	...	...	
,, ,,	1 P.M.	29·87	...	South.	3	Overcast squally weather.
,, ,,	1-30 P.M.	29·85	...	...	...	
,, ,,	2 P.M.	29·83	...	S.-W by S.	2	Squally weather.
,, ,,	2-30 P.M.	29·83	...	...	...	
,, ,,	3 P.M.	29·82	...	S. by W.	2	Cloudy.
,, ,,	3-30 P.M.	29·82	...	...	...	
,, ,,	4 P.M.	29·82	...	S. E.	2	Cloudy blue sky.

Log of H. M. I. M. S. "Clive" —concluded.

Date.	Hour.	HEIGHT OF		WIND.		Weather.
		Barometer.	Thermometer.	Direction.	Force.	
1st November	8 P.M.	29·92	86	...	...	
" "	11 P.M.	...	...	S.-S.-E.	...	
" "	Midnight	29·86	85	S.-S.-E.	2	Blue misty sky.

Log of the B. I. S. N. Company's Steamer "Bhandara."

30th October	1 P.M.	...	...	W.-N.-W.	...	
" "	2 P.M.	...	...	"	...	Heavy rain and squally.
" "	4 P.M.	29·69	78	"	...	Same weather as at 2 P.M.
" "	8 P.M.	29·74	76	"	...	Squally with rain.
" "	10 P.M.	29·75	76	"	...	Incessant rain.
" "	Midnight.	29·69	76	"	...	Constant rain, with heavy squalls.
31st October	2 A.M.	29·69	80	"	...	
" "	4 A.M.	29·66	80	"	...	Hard squalls of wind and rain.
" "	6 A.M.	29·67	75	"	...	Strong current to the southward.
" "	8 A.M.	29·69	75	"	...	Heavy squalls of wind and rai High and confused sea.
" "	10 A.M.	29·65	75	W.-N.-W.	...	Heavy north-east swell.
" "	Noon	29·57	75	"	...	Heavy squalls with thick rain; hig and confused sea.
" "	1 P.M.	...	...	W. by N.	...	
" "	2 P.M.	29·50	78	"	...	Heavy rain and high wind.
" "	4 P.M.	29·45	75	"	...	Heavy westerly gale, with incessan rain and east-north-east sea.
" "	6 P.M.	29·30	75	"	...	
" "	8 P.M.	29·18	77	W.-S.-W.	...	Rain throughout. Hard gale. Heav and frequent squalls and a high con fused north-north-east sea.
" "	9 P.M.	29·15	77	"	...	
" "	9-50 P.M.	...	...	S.-W.	...	Sudden shift of the wind to south west. Blowing with hurricane force.
" "	11 P.M.	29·23	78	S. W.	...	Wind still hauling to the southward.
" "	Midnight	29·56	78	S.	...	Wind moderating, but still blowin hard in squalls.
1st November	1 A.M.	...	...	S.-W.	...	
" "	2 A.M.	29·54	80	"	...	
" "	4 A.M.	29·60	80	"	...	
" "	6 A.M.	29·64	81	S.-W.	...	
" "	8 A.M.	29·70	82	S.-W.	...	
" "	9 A.M.	...	...	S.-E.	...	
" "	10 A.M.	29·72	82	S.-E.	...	
" "	Noon	29·74	82	"	...	Moderate breeze. Weather moderat ing.
" "	4 P.M.	29·75	82	"	...	Moderate breeze and fine weather.
" "	8 P.M.	29·79	81	"	...	
" "	9 P.M.	...	...	East.	..	
" "	Midnight	29·81	82	"	...	Moderate breeze and fine weather.
2nd November	4 A.M.	29·80	78	"	...	Moderate breeze and fine weather.
" "	5 A.M.	...	...	E.-S.-E.	...	
" "	8 A.M.	29·80	80	"	...	Light breeze and fine weather.
" "	10 A.M.	...	...	Variable.	...	
" "	Noon	29·79	86	"	...	Variable airs and fine.

Log of the S. S. "Sirsa."

Date.	Hour.	Height of		Wind.		Weather.
		Barometer.	Thermometer.	Direction.	Force.	
October 30th	8-45 A.M.	29·84	...	N.-N.-E.	...	Ship rolling very heavily. Strong breeze, with high cross sea. Carried away main trysail gaff.
,, ,,	Noon.	29·84	...	N by E.	...	Strong breeze, with high cross sea; rain at times; ship rolling heavily.
,, ,,	4 P.M.	29·74	...	N.-E.	...	Strong breeze and squally, with high confused sea.
,, ,,	6 P.M.	...	...	N.-N.-E.	...	Reduced speed 2 knots.
,, ,,	8 P.M.	29·76	...	N.	...	Strong breeze, squally, with high confused sea. Ship rolling violently.
,, ,,	Midnight.	29·75	...	N.-E. by N.	...	The same weather.
,, 31st	2 A.M.	...	...	N.-W.	9	Heavy gale with frequent squalls. Heavy rain and very high, confused sea.
,, ,,	2-45 A.M.	...	...	,,	...	Topsail blown away.
,, ,,	4 A.M.	29·56	...	,,	...	
,, ,,	8 A.M.	29·50	...	N.-W. by W.	9	Hard gale with very high confused sea.
,, ,,	10 A.M.	29·45	...	...	6	Hard squalls; ship pitching. Blowing heavily.
,, ,,	Noon.	29·38	...	...	6	Same weather.
,, ,,	1 P.M.	29·27	...	W.-N.-W.	...	Thunder and lightning. Blowing heavily.
,, ,,	2 P.M.	29·18	...	W.	9	Terrific gale, with hard squalls and thick heavy rain; increasing sea. Ship labouring and straining heavily.
,, ,,	2-30 P.M.	29·18	...	W.	...	Shipped heavy sea; aft carried away mail boat and smashed poop ventilators.
,, ,,	3 P.M.	29·18	...	W.	9	Same weather as at 2 P.M.
,, ,,	4 P.M.	29·05	...	W.	9	Ditto.
,, ,,	5 P.M.	...	...	W.-S.-W.	9	Ditto.
,, ,,	6 P.M.	28·94	...	...	10	Terrific gale and high sea. Ship labouring and straining very heavily. Shipped a heavy sea, breaking in No. 2 hatch and washing forward gangway ladder, bridge ventilators, and other gear from off the deck.
,, ,,	7 P.M.	28·82	...	...	10	Same weather as at 6 P.M.
,, ,,	8 P.M.	28·84	...	S.-W.	10	Ditto.
,, ,,	9 P.M.	28·84	...	S.-W.	10	Ditto.
,, ,,	10 P.M.	28·86	...	..	10	Ditto.
,, ,,	11 P.M.	28·86	...	S.	10	Ditto.
,, ,,	Midnight.	28·96	...	S.	9	Hard gale and high sea running. Ship rolling and pitching very heavily. Hard rain squalls at times.
November 1st	2 A.M.	29·50	...	S.-E.	8	Wind and weather slightly moderating.
,, ,,	4 A.M.	29·52	...	...	9	Still hard gale with heavy squalls and high sea. Ship labouring and straining heavily and shipping much water.
,, ,,	5 A.M.	...	...	...	...	Observed Madras.
,, ,,	6 A.M.	...	...	S.-S.-E.	...	
,, ,,	7-50 A.M.	...	...	...	...	Anchored off Madras.

APPENDIX C.

Extract from the Log Book of the S. S. "Idar," from Aden to Bombay, on 7th November 1888.

Hours.	Courses.	Distance run.		Wind direction.	Barometer corrected.	Thermometer corrected.	Remarks.
		Knots.	Fathoms				
1 A.M.	N. 65 E.	11	4	N.-N.-E.	...	...	A.M. Moderate gale; overcast sky.
2 A.M.	...	11	4	...	...	...	
3 A.M.	...	11	4	...	...	...	
4 A.M.	...	11	4	...	...	...	
5 A.M.	...	...	...	...	...	...	5. Very hard squalls; wind hauling to easterly.
6 A.M.	...	...	...	...	...	...	6. In all sail.
8 A.M.	...	...	...	...	...	...	8. Fresh gale with very confused and high sea. Seas coming from north-north-east and east-south-east, causing a dangerous sea.
Noon	...	...	...	...	29·65	...	Noon: secured everything about the decks.
...	N. 76° E.	...	248	Lat. 17°	obs. 31′	... ...	Long. obs. Distance and bearing. 66° 02′ 393 N. 78 E.
1 P.M.	N. 65 E.	7	...	N.-N.-E.	...	...	0-30. Fresh gale.
2 P.M.	N. 60 E.	...	...	...	...	...	
4 P.M.	...	...	...	...	...	...	4. P.M. Hard gale with very dangerous sea. Ship taking large quantities of water on board, fore and aft. Secured all ventilators.
5 P.M.	N.-E.	6	...	...	...	...	
7 P.M.	...	...	...	N.-E.-N.	...	...	At sunset sky very red, and weather looking bad.
8 P.M.	...	...	...	...	29·45	...	8. P.M. Hard gale with hard squalls; sea very high and confused.
12 P.M.	...	...	...	...	29·30	...	Mid. Lightning to north-east.

Extract from the Log Book of the S. S. "Idar," from Aden to Bombay, on 8th November 1888.

1 A.M.	N.-E.	6	...	N.-N.-E.	...	...	2. A.M. Hard gale, evidently cyclonic. Sea very confused and high; ship taking large quantities of water on board.
2 A.M.	N.-E.-N.	...	...	...	...	...	
3 A.M.	N.-E.-N.½ N.	...	...	...	...	...	2-20. A.M. Squalls increasing in force; weather thick and clouds very low.
4 A.M.	...	...	...	...	29·25	...	
5 A.M.	...	5	...	...	...	...	5. A.M. Barometer all oscillating violently, tenth each way.
6 A.M.	...	...	...	...	...	...	
7 A.M.	...	...	...	...	...	...	7. A.M. Slight rise in barometer, 29·28. Weather continues the same.
8 A.M.	...	...	...	...	...	...	8. A.M. Very hard squalls and sea very high.
9 A.M.	...	...	...	...	...	...	
10 A.M.	...	...	...	..	...	...	10-30 A.M. Wind shifted to north-north-west; very hard squalls. Barometer shows a slight fall and oscillating slightly.
11 A.M.	...	...	...	...	...	...	Till now the gale has been of cyclonic force and character.
Noon	N. 52 E.	...	...	...	29·26	...	Noon. Weather much the same. Sea more northerly and regular.

Extract from the Log Book of the S S. "Idar," from Aden to Bombay, on 8th November 1888—continued.

Hours.	Courses.	Distance run.		Wind direction.	Barometer corrected.	Thermometer corrected.	Remarks.
		Knots.	Fathoms				
1 P.M.	N.-E.-N.½ N.	6	...	N.-W.	...	...	No observations.
2 P.M.	...	...	...	...	..	...	2 P.M. Sky gloomy and wind shifting westerly. Sea coming from north-east and north.
3 P.M.	...	...	...	W.-N.-W.	...	...	
4 P.M.	...	...	...	...	Bar. steady	...	4 P.M. Wind west-north-west. Sea and sky much the same.
5 P.M.	...	7	...	...	...	...	
6 P.M.	...	...	...	...	...	...	6 P.M. Sea and wind decreasing fast, but hard squalls at intervals.
7 P.M.	...	...	...	...	...	...	
8 P.M.	...	...	...	...	29·40	...	8 P.M. Brisk squally breeze. Sky overcast.
9 P.M.	N. 85 E.	10	...	...	...	...	
10 P.M.	S. 85 E.	...	...	S.-W.	...	...	10 P.M. Wind shifting to south-west with lightning to north and north-west.
11 P.M.	...	...	...	...	...	...	
12 P.M.	...	...	...	...	...	...	Midnight. Fresh breeze. Sky overcast.

Extract from the Log Book of the S. S. "Idar," on 9th November 1888.

1 A. M.	S. 85 E.	10	4	S.-W.	...	...	Fresh breeze shifting southerly. Sea going down and sky improving, but heavy banks on the horizon. Lightning to E.-N. and N.-W.
2 A.M.	...	...	...	...	...	...	
3 A.M.	...	...	...	S.-S.-W.	...	...	
4 A.M.	...	...	...	...	...	...	4 A.M. Frequent squalls of lightning to N.-E., but becoming less vivid.
5 A.M.	...	...	...	...	...	...	
6 A.M.	...	11	...	...	...	...	
7 A.M.	...	...	...	...	...	...	
8 A.M.	...	...	...	...	29·62	...	8 A.M. Fresh breeze from S.-S.-W. Weather clearing and sea comparatively smooth.
9 A.M.	...	...	...	...	...	...	
10 A.M.	...	...	...	...	...	...	
11 A.M.	...	...	...	...	...	...	
12 A.M.	S. 85 E.	199	...	...	29·65	...	Long. obs.
				Lat. 18°	52 N.	Obs.	71° 34′ Bearing S. 82 E. and 70.′ distance.
1 P.M.	...	12	...	...	..	...	P. Watery looking sky and moderate breeze.

Extract from the Log Book of the S. S. "Purulia," on 8th November 1888.

1 A.M.	S. 40 E.	9	2	E.	...	...	
4 A.M.	...	...	...	...	29·89	82	Strong easterly wind. Moderate sea. Ship pitching heavily and cloudy.
5 A.M.	S. 43½ E.	8	10	...	...	...	
6 A.M.	...	9	2	...	...	...	
7 A.M.	...	9	2	...	...	...	7-10. Observed *Dwarka*.
8 A.M.	...	9	2	...	29·94	82	8. Strong breeze. Moderate sea, but heavy southerly swell and hazy.
10 A.M.	...	...	...	E.-S.-E.	...	...	
11 A.M.	S. 47 E.	...	...	...	...	...	
12 A.M.	1	...	...	...	29·86	83	Noon. Moderate breeze and cloudy. Long southerly swell. Ship pitching heavily.

Extract from the Log Book of the S. S. "Purulia," on 8th November 1888 —continued.

Hours.	Courses.	DISTANCE RUN.		Wind direction.	Barometer corrected.	Thermometer corrected.	REMARKS.
		Knots.	Fathoms				
...	...	...	...	Observed Lat.	21°	49′	N. Longitude 69° 11′, E. Current N. 84° W.
1 P.M.	S. 50 E.	8	4	E.-S.-E.	...	...	
2 P.M.	...	9	...	...	...	...	
3 P.M.	S. 54 E.	9	...	...	...	...	3-10 P.M. Porbunder abeam, Dis. 5 minutes
4 P.M.	...	9	...	...	29·81	82	4 P.M. Fresh head wind, thick drizzling rain, and moderate sea with high southerly swell.
5 P.M.	...	9	...	E.-N.-E.	...	...	
6 P.M.	...	8	8	N.-E.	...	...	
7 P.M.	...	9	...	...	...	...	
8 P.M.	...	9	...	...	29·84	83	8 P.M. Unsteady breeze and heavy rain throughout. Very heavy southerly swell.
9 P.M.	...	8	...	...	...	...	
10 P.M.	...	...	...	Variable.	...	...	10-30 P.M. Verawal Light abeam.
11 P.M.	...	...	...	...	...	...	
12 P.M.	...	...	...	...	29·77	80	Mid. Heavy head sea, with hard squalls of rain and wind. Ship pitching and rolling heavily.

Extract from the Log Book of the S. S. "Purulia," on 9th November 1888.

1 A.M.	S. 49 E.	8	0	South	...	...	2-30 A.M. Reduced engines to half speed; heavy squall passing.
2 A.M.	...	...	...	...	...	...	
3 A.M.	...	...	...	...	...	...	2-50 A.M. Full speed ahead.
4 A.M.	...	...	...	...	29·75	80	
5 A.M.	S. 49 E.	...	...	Southerly	...	...	4-0 A.M. Fresh gale with heavy rain squalls and heavy sea. Ship pitching and rolling heavily.
6 A.M.	...	...	...	...	...	...	
7 A.M.	...	..	...	...	...	...	
8 A.M.	...	...	...	...	29·85	82	8 A.M. Modreate to fresh gale with frequent heavy rain squalls. Ship rolling and pitching heavily and taking large quantities of water, fore and aft.
9 A.M.	...	8	4	...	...	...	
10 A.M.	...	...	...	...	...	...	
11 A.M.	...	...	...	...	...	...	
12 A.M.	...	...	...	...	29·88	82	
			Lat.	19°	48′ N.	...	
			Long.	71°	49′ E.	...	Noon. Gale moderating; current N. 25° W.

Extract from the Log Book of the S. S. "Hampstead," from Bombay to Karachi, 8th November 1888.

12 A.M.	...	...	...	...	...	...	0—30 P.M. Steamed out of dock.
2 P.M.	...	...	...	...	...	...	2-30 P.M. Weighed anchor and proceeded.
6 P.M.	N.-W.	...	...	South.	...	...	
8 P.M.	...	...	...	...	29·32	...	8 P.M. Light breeze and beam sea.
9 P.M.	...	...	...	...	...	...	Ship rolling heavily.
10 P.M.	...	...	...	...	...	...	10 P.M. Moderate breeze and fine weather, with beam swell.
12 P.M.	N.-W. ¼ W.	...	...	...	29·27	...	Mid. Ship rolling heavily.

Extract from the Log Book of the S. S. "Hampstead," on 9th November 1888.

Hours.	Courses.	DISTANCE RUN.		Wind direction.	Barometer uncorrected.	Thermometer uncorrected.	REMARKS.
		Knots.	Fathoms				
2 A.M.	N.-W. ¼ W.	...	...	South	...	...	Strong wind, with rain squalls; heavy sea. Ship rolling heavily.
4 A.M.	W. ½ S.	...	...	...	29·21	...	4-20 A.M. Hauled ship up to ease her rolling.
8 A.M.	W. ½ S.	...	...	South	29·24	...	8 A.M. Strong wind and heavy sea. Ship rolling very heavily.
10 A.M.	N.-W.	...	...	South	...	...	
12 A.M.	...	...	...	...	Lat	N. 20°21′	Long: 70·36E.
2 P.M.	N.-W.	...	...	West	...	...	2 P.M. Wind and sea gradually moderating.
4 P.M.	N.-W.	...	...	West	29·22	...	4 P.M. Weather fair.
6 P.M.	...	...	...	N.-W.	...	...	
8 P.M.	N.-W.	...	...	N.-W.	29·28	...	8 P.M. Fresh breeze and cloudy; moderate head sea.
10 P.M.	N.-W. ¼ N.	...	...	N.	...	...	
12 P.M.	...	...	...	...	29·33	...	Mid. Fresh breeze and cloudy; sea moderate.

Extract from the Log Book of the S. S. "Pachamba," from Bombay to Karachi, on 8th November 1888.

1 P.M.	...	...	...	...	...	...	Left Bombay.
2 P.M.	N. 47 W.	3	4	...	...	...	
3 P.M.	...	9	4	...	...	...	
4 P.M.	...	...	...	S.-W.-S.	29·84	86	4 P.M. Light wind, with passing clouds.
8 P.M.	...	10	...	S.-S.-E.	29·92	84	8 P.M. Moderate wind and cloudy.
12 P.M.	...	...	...	Do.	29.88	82	Midnight. Strong breeze and overcast with lightning to N.-W.

Extract from the Log Book of the S. S. "Pachamba," on 9th November 1888.

1 A.M.	N. 47 W.	10	...	...	...	...	
2 A.M.	...	...	...	...	...	...	2-30 A.M. Hard squalls.
4 A.M.	...	...	...	S.-S.-E.	29·78	84·0	4 A.M. Moderate gale, with hard squalls and heavy rain. High cross sea.
5 A.M.	N.-N.-W.	...	...	...	...	...	
6 A.M.	...	...	...	S.-S.-E.	29·76	...	6 A.M. Weather getting worse.
8 A.M.	N. 47 W.	...	...	S.-S.-E.	29·76	82·0	8 A.M. Strong gale and high cross sea, with heavy squalls; sighted Verawal north-west west. Shipping heavy water.
9 A.M.	...	10	...	S.-S.-E.	29·73	...	8-40 A.M. Verawal east.
					·74	...	9-20 A.M. Hove ship to with head to south-west; high increasing cross sea with squalls of cyclonic force. Engines going dead slow.
10 A.M.	Hove to off	...	...	S.-S.-E.	29·76	...	
					·76	...	
11 A.M.	Verawal	...	...	S. by W.	29·76	...	
					·76	...	
12 A.M.	...	...	...	S. by W.	29·76	82·0	Noon. Weather very slightly moderating.
1 P.M.	...	...	...	S.-S.-W.	29·75	...	
					29·74	...	
					·73	...	
2 P.M.	...	...	...	S.-W.	29·74	...	
					·74	...	
3 P.M.	N. 40 W.	2	...	S.-W.	29·74	...	3-40 P.M. Mangrol east.
					·75	...	
4 P.M.	...	8	...	S.-W. by W.	29·76	83·0	4 P.M. Strong moderating gale and high cross sea.

Extract from the Log Book of the S. S. "Pachamba," on 9th November 1888—continued.

Hour.	Courses magnetic.	DISTANCE RUN.		Wind direction.	Barometer corrected.	Thermometer corrected.	REMARKS.
		Knots.	Fathoms				
5 P.M.	...	...	...	W. by N.	...	...	
6 P.M.	...	...	...	...	...	...	
7 P.M.	...	...	...	N.-W.	...	...	7-45 P.M. Sighted Porebunder. Light north-north-west.
8 P.M.	...	...	...	...	...	...	8 P.M. Fresh wind with sharp squalls; sea moderating.
9 P.M.	...	8	4	...	...	...	
10 P.M.	...	8	4	...	...	...	9-5 P.M. Porebunder Lt. 5 'dis.
11 P.M.	...	8	4	...	...	...	Mid. Strong wind and overcast. Moderate sea.
12 P.M.	...	8	4	...	...	...	

Extract from the Log Book of the S. S. "Calder," from Bombay to Busserah, on 8th November 1888.

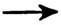
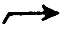
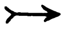
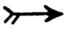
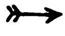
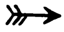
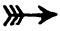
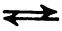
1 AM.	...	...	...	Variable.	...	...	
6 A.M.	N. 72 W.	...	...	...	...	...	Left Bombay.
2 A.M.	...	...	...	...	29·90	89	Noon. Moderate breeze and fair throughout.
1 P.M.	N. 72° W.	...	...	...	...	...	
4 P.M.	...	...	...	...	...	...	4 P.M. Moderate breeze, with passing clouds throughout. Sea moderate.
5 P.M.	...	...	...	...	...	...	
8 P.M.	...	91	...	...	29·90	86	8 P.M. Weather and sea as above.
2 P.M.	...	...	...	...	29·86	84	Midnight. Increasing wind and sea, with passing clouds throughout.

Extract from the Log Book of the S. S. "Calder," on 9th November 1888.

1 A.M.	N. 72 W.	...	...	S.-E. to E.?	29·78	...	Begins with increasing wind and sea.
2 A.M.	...	...	...	...	·76	...	
3 A.M.	...	...	...	...	·76	...	
4 A.M.	...	142	...	...	·74	82	4 A.M. Strong winds, with high sea and passing heavy squalls, and rain middle and latter part of watch. Ship pitching and rolling very heavily and taking water over fore and aft.
A.M.	N. 38 W.	160	...	...	29·78	...	8 A.M. Moderate gale, with high confused sea. Ship labouring very heavily and taking large quantities of water over fore and aft.
A.M.	...	183	...	...	29·78	...	8-40 A.M. Heavy squalls, with rain. Noon. Heavy squalls, with rain.
	N. 65° W.	196		Lat.	obs.	...	Long.
				20°	32′ N.	...	69°34′ E.
P.M.	N. 38 W. N. 53 W.	...	...	S.-E.?	...	...	
4 P.M.	...	24	...	S.-W. to South ?	29·78	82	4 P.M. Decreasing wind, with weather more fair and high confused sea. Ship pitching and rolling very heavily at times through, and taking heavy water, over forward.
P.M.	...	...	...	...	29·80	81	
P.M.	...	...	...	W.-S.-W.?	...	...	
P.M.	...	47	...	...	29·80	80	8 P.M. Weather and sea as above.
P.M.	N. 72 W.	...	...	...	...	...	
P.M.	...	...	...	N.-W.?	...	...	
P.M.	...	70	...	...	29·88	80	Midnight. Fresh winds, with passing heavy clouds throughout.

APPENDIX D.

List of Symbols used in the Charts in Cyclone Memoirs, Part III, for Wind and Weather.

Wind force.	Symbol.	Weather and Sea.	Symbol.
0 to 1		Clear	b
2 to 3		Cloudy	c
4 to 5		Overcast	o
6 to 7		Rain	r
8 to 9		Sea	s
10 to 11		Squally	q
12		Thunder and	t
Variable.		Lightning	

Different intensities of rain, sea, squally weather, thunder and lightning are indicated by addition of one to three bars underneath, *e.g.*:—

Rain.	Symbol.	Sea.	Symbol.
Showery	r	Slight sea	s
Moderate rain	$\underline{r}$	Rough sea	$\underline{s}$
Heavy rain	$\underline{\underline{r}}$	High sea	$\underline{\underline{s}}$
Torrental rain	$\underline{\underline{\underline{r}}}$	Tremendous sea	$\underline{\underline{\underline{s}}}$

Squally weather.	Symbol.	Thunder and Lightning.	Symbol.
Light	q	Distant	t
Moderate	$\underline{q}$	Approaching	$\underline{t}$
Hard	$\underline{\underline{q}}$	Heavy	$\underline{\underline{t}}$
Terrific	$\underline{\underline{\underline{q}}}$	Incessant	$\underline{\underline{\underline{t}}}$

300

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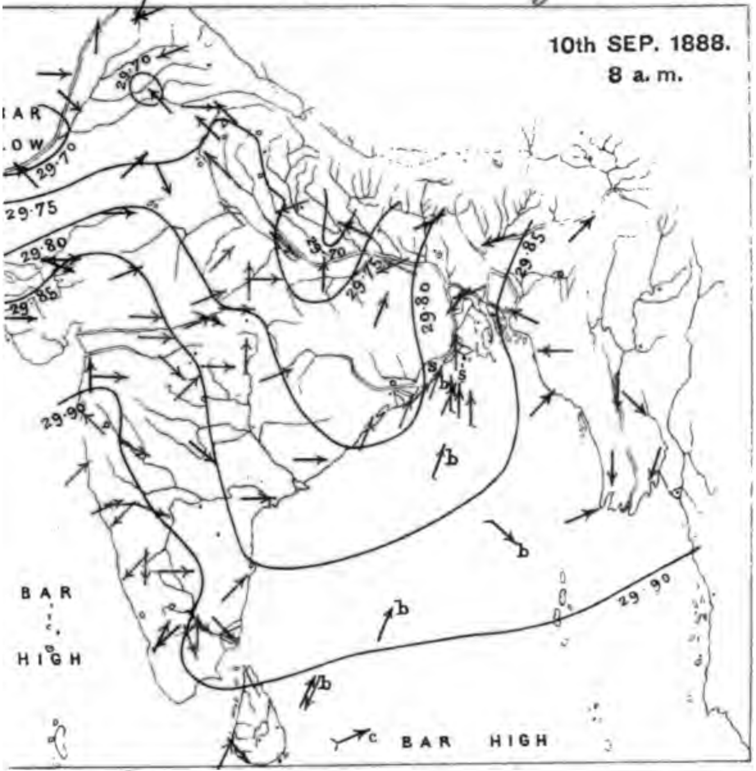
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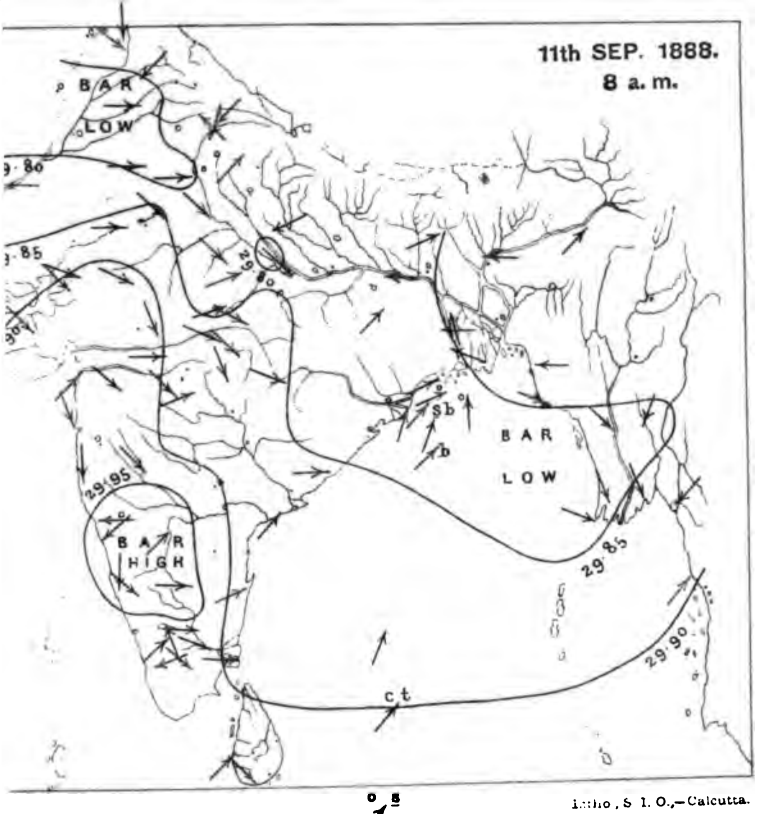
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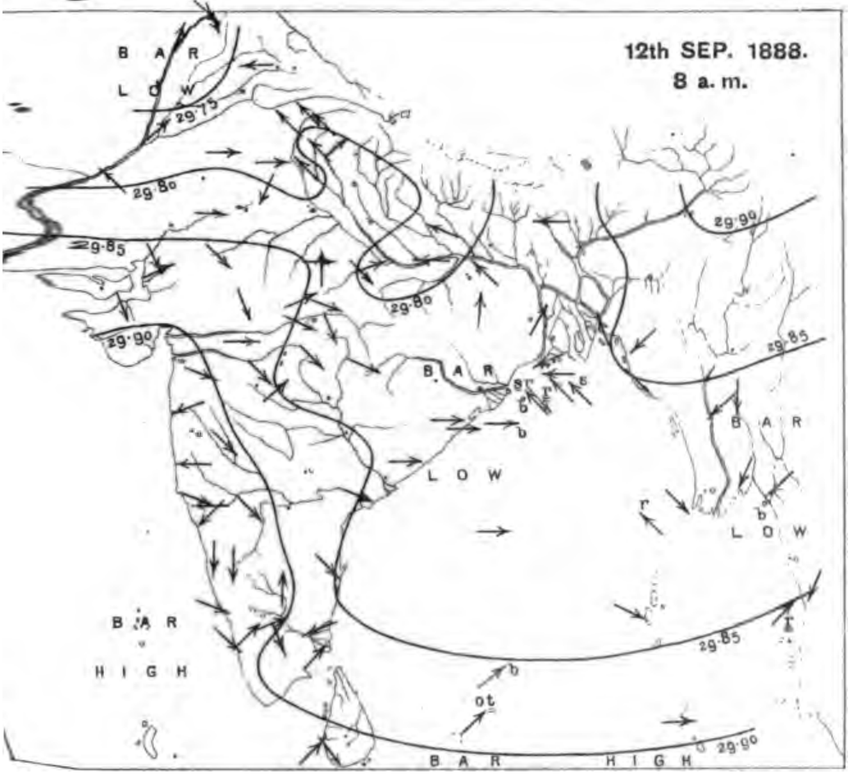
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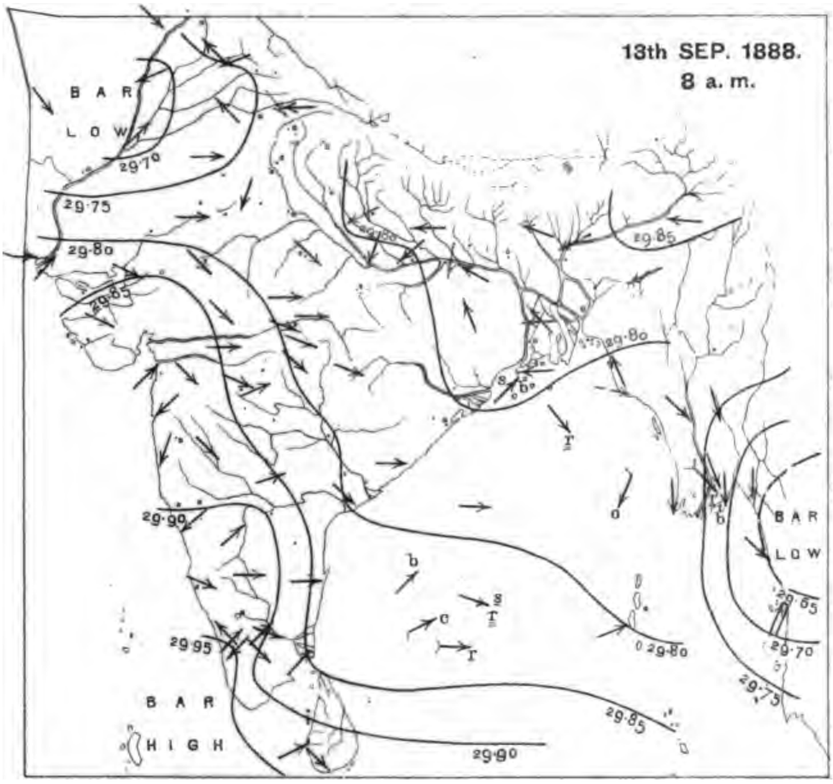
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8 a.m.

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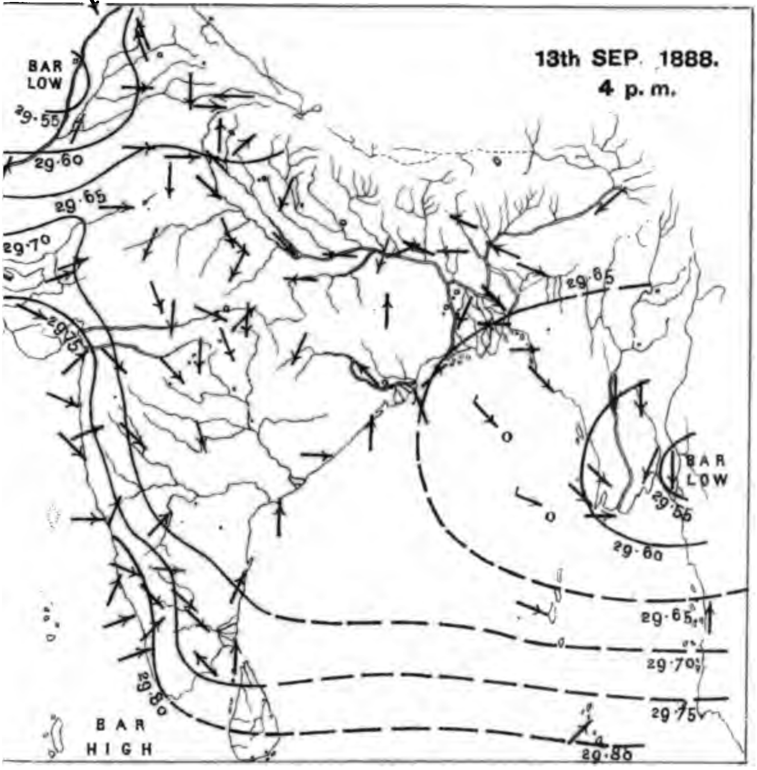

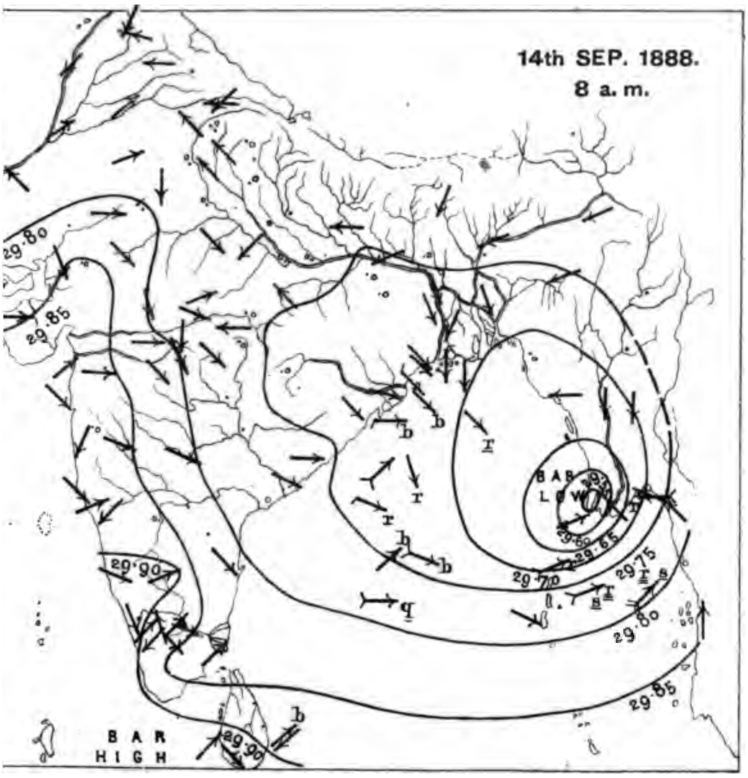

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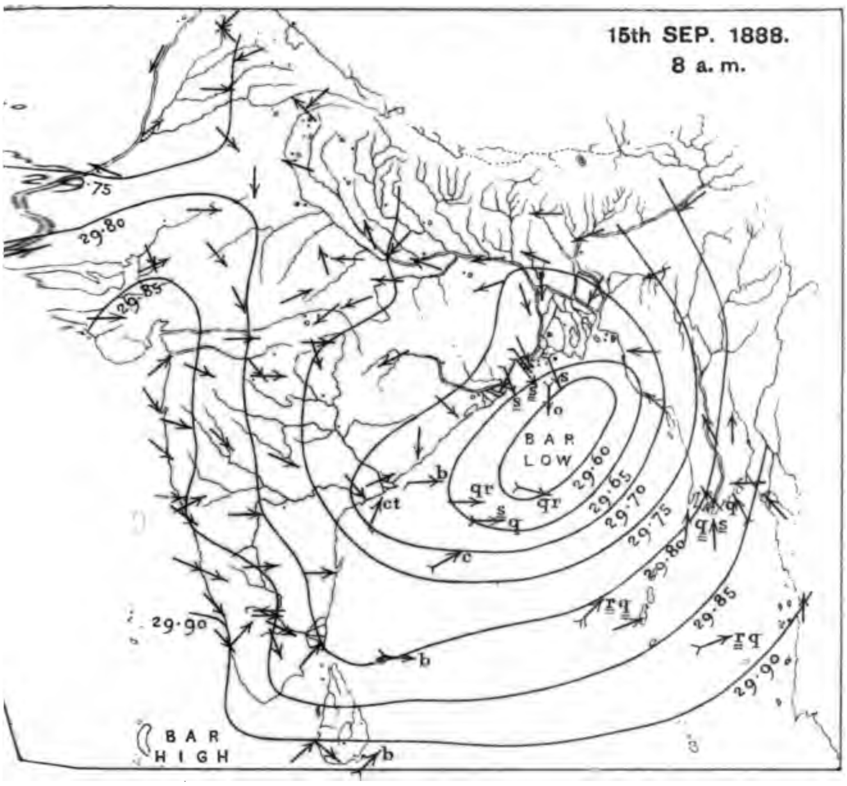

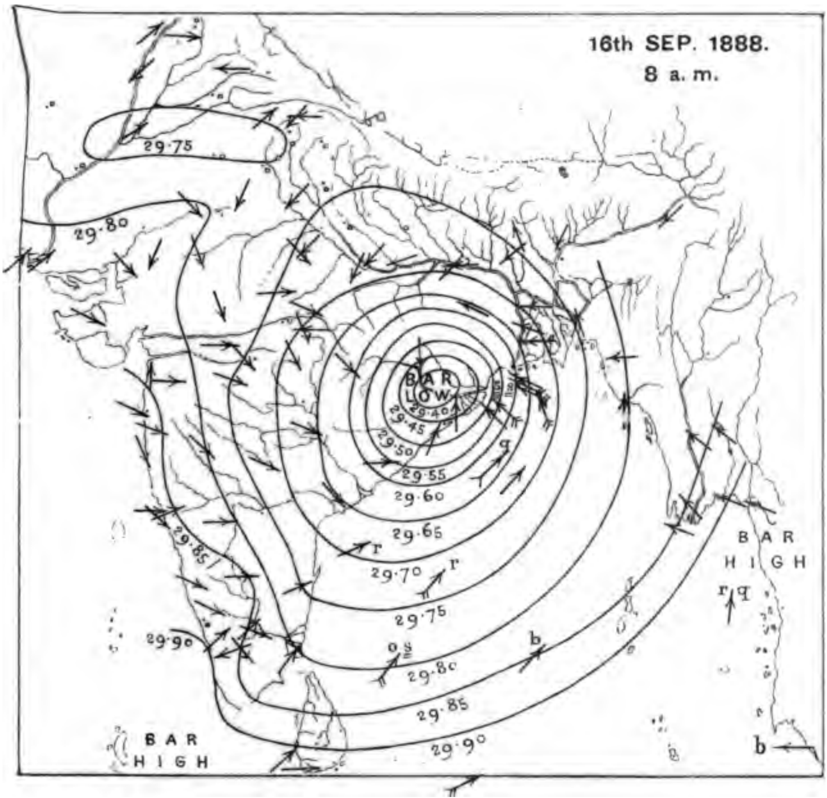

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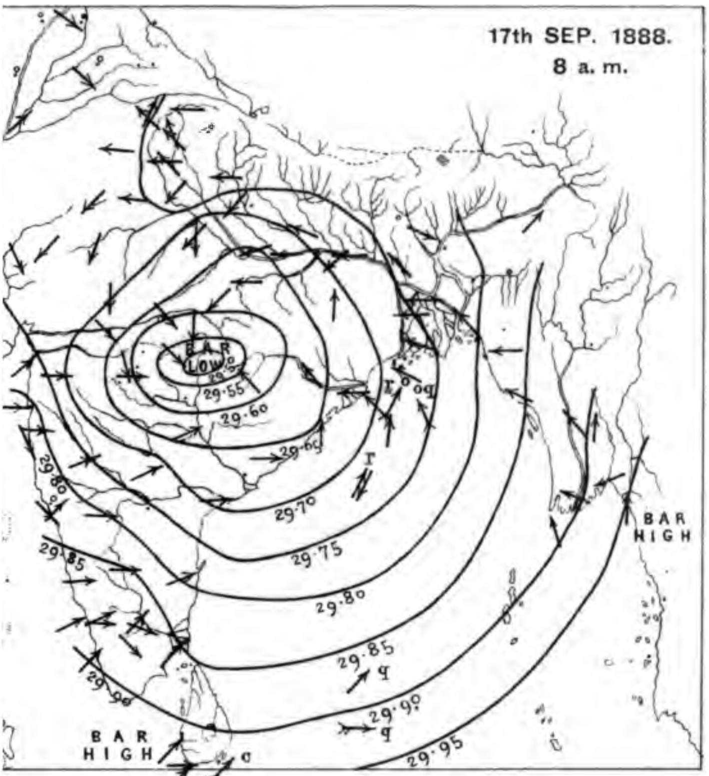

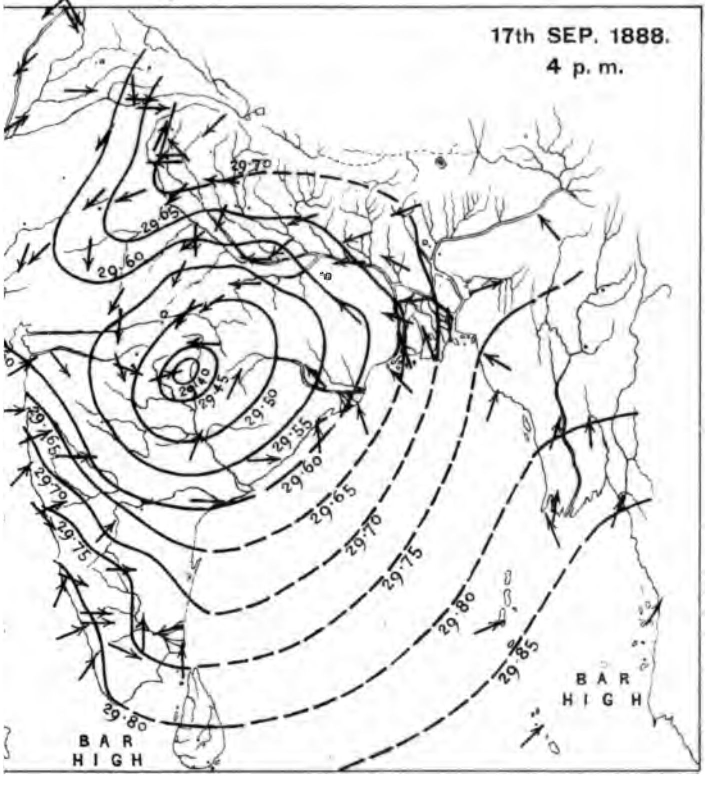

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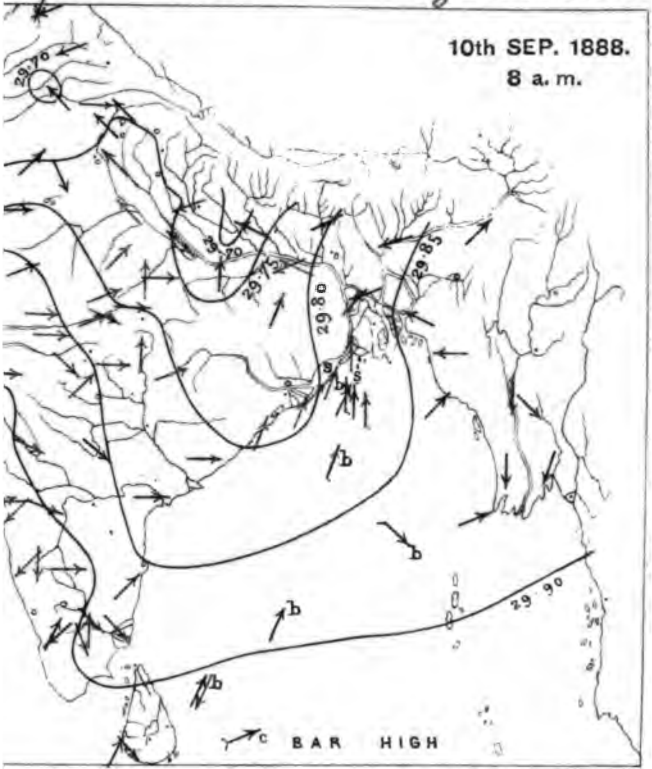
300a



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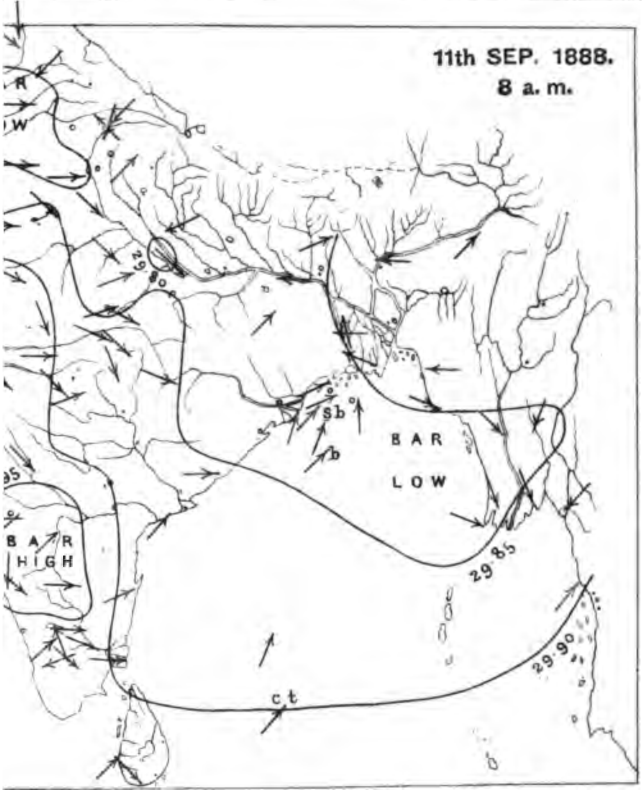

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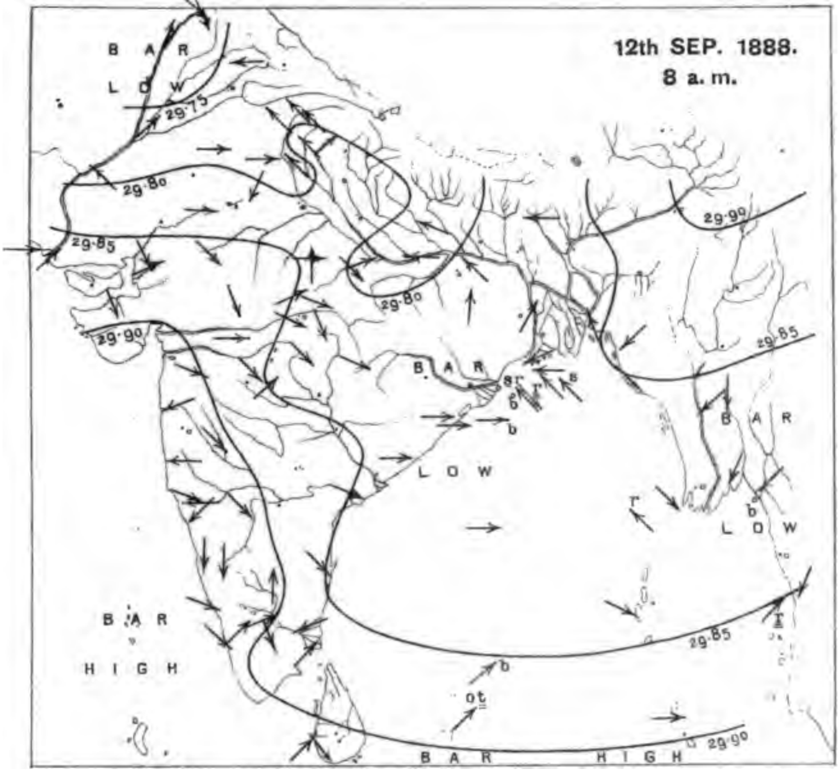

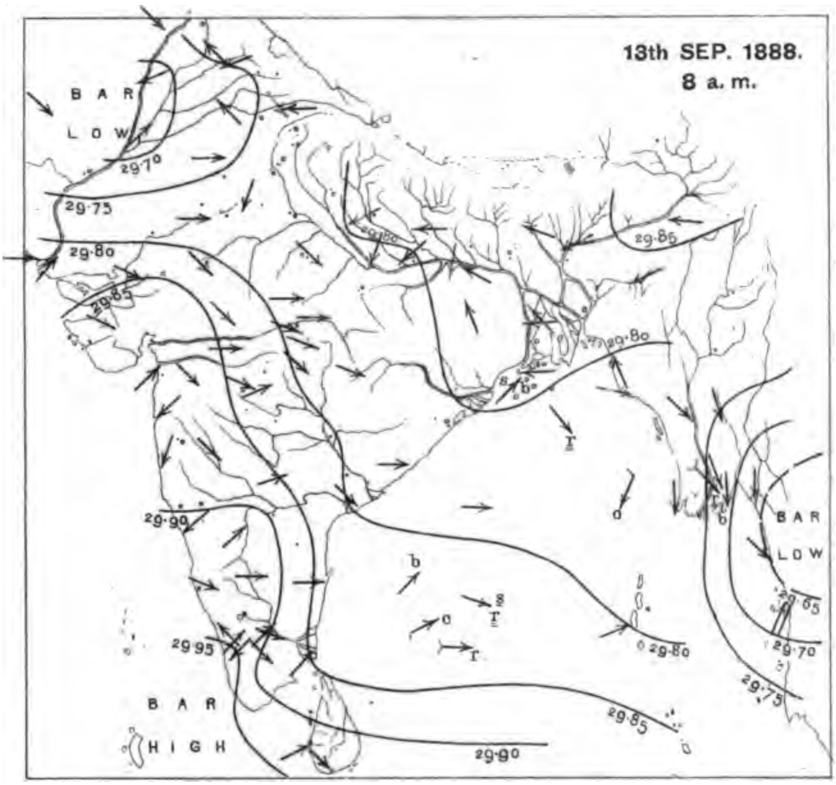

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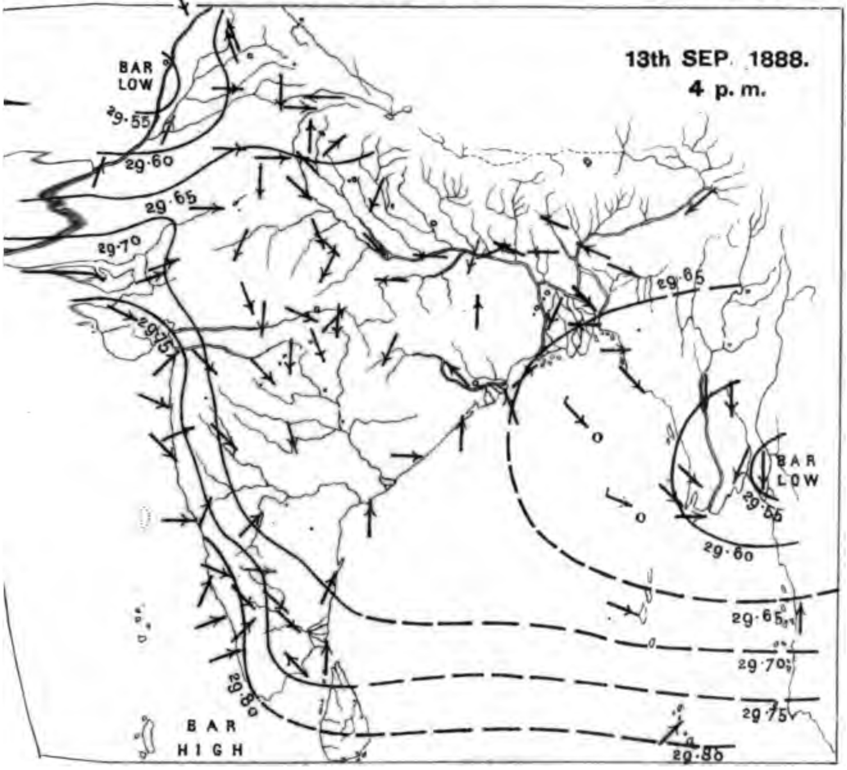
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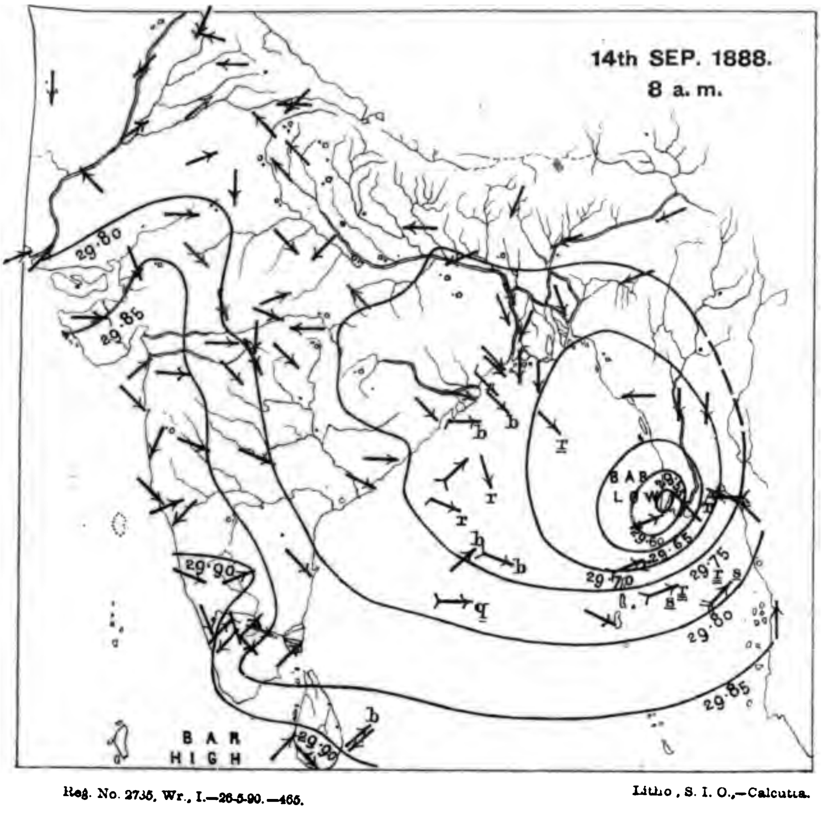
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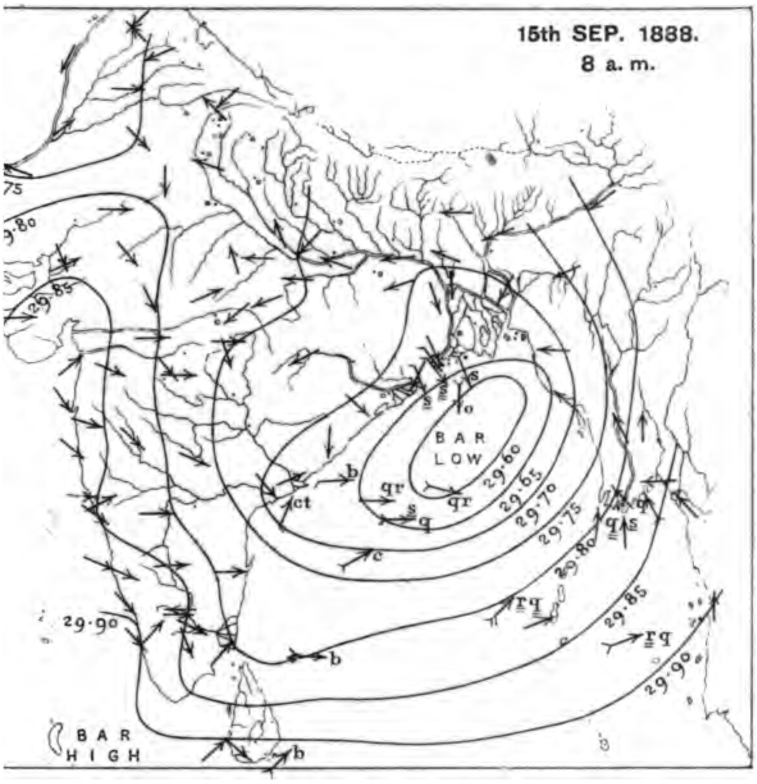

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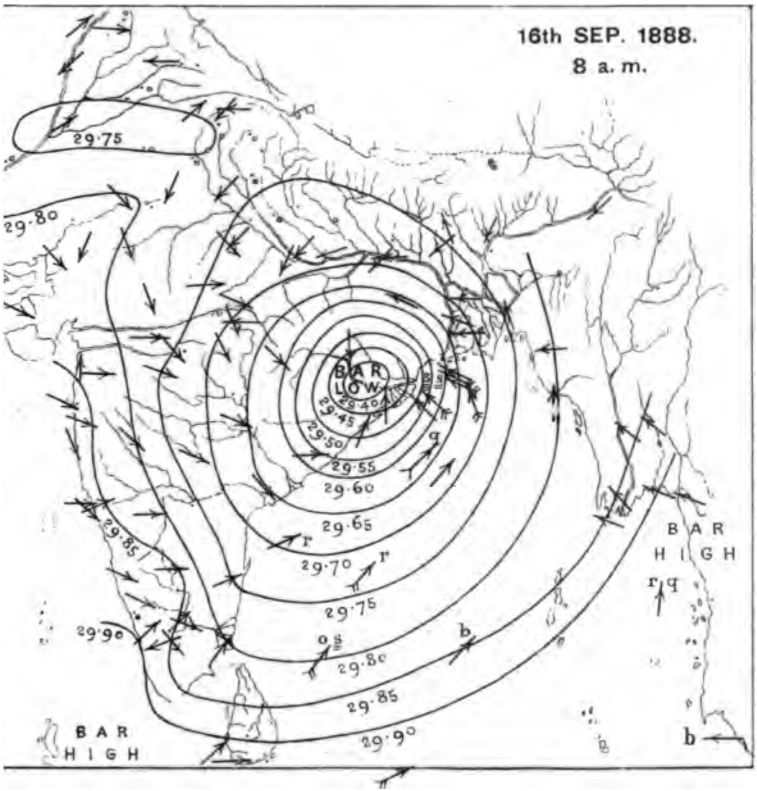

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8 a.m.

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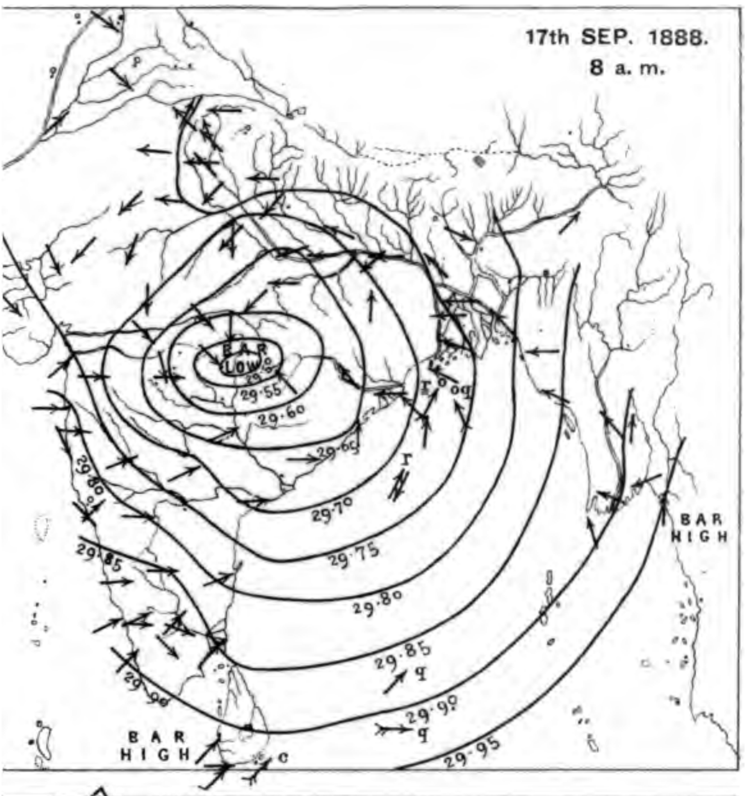

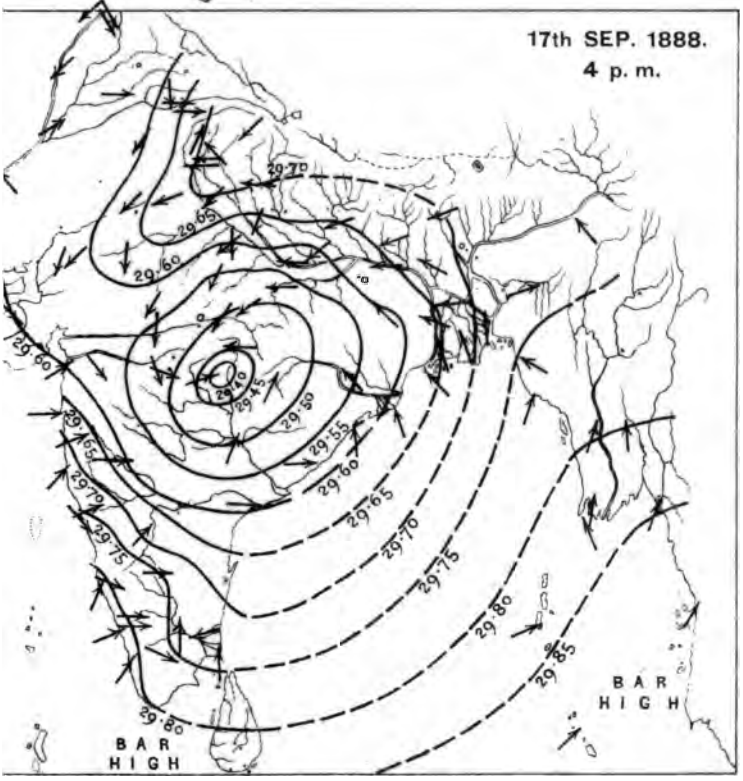

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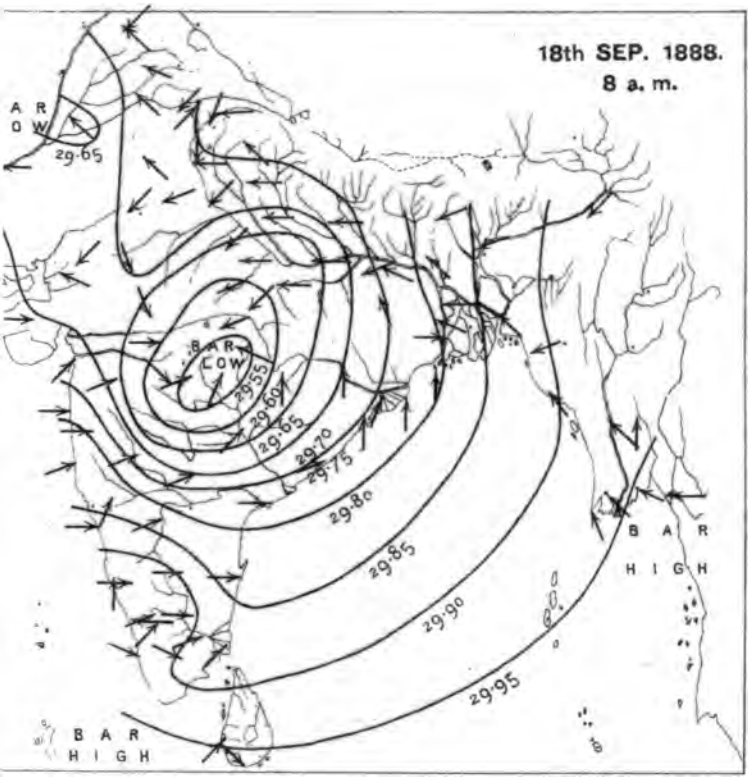

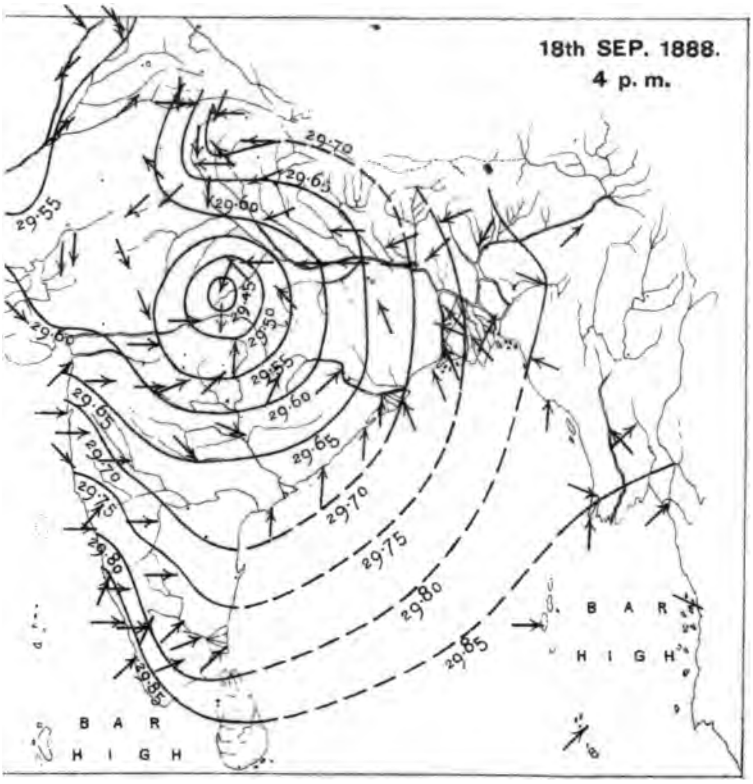

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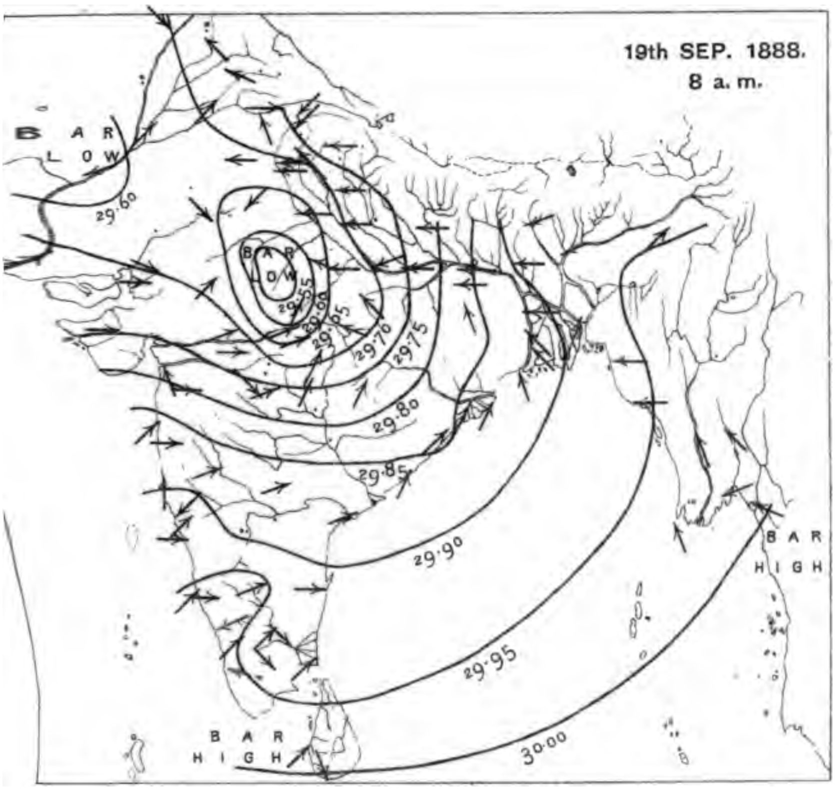
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8 a. m.
BAR LOW
BAR LOW
BAR HIGH
BAR HIGH
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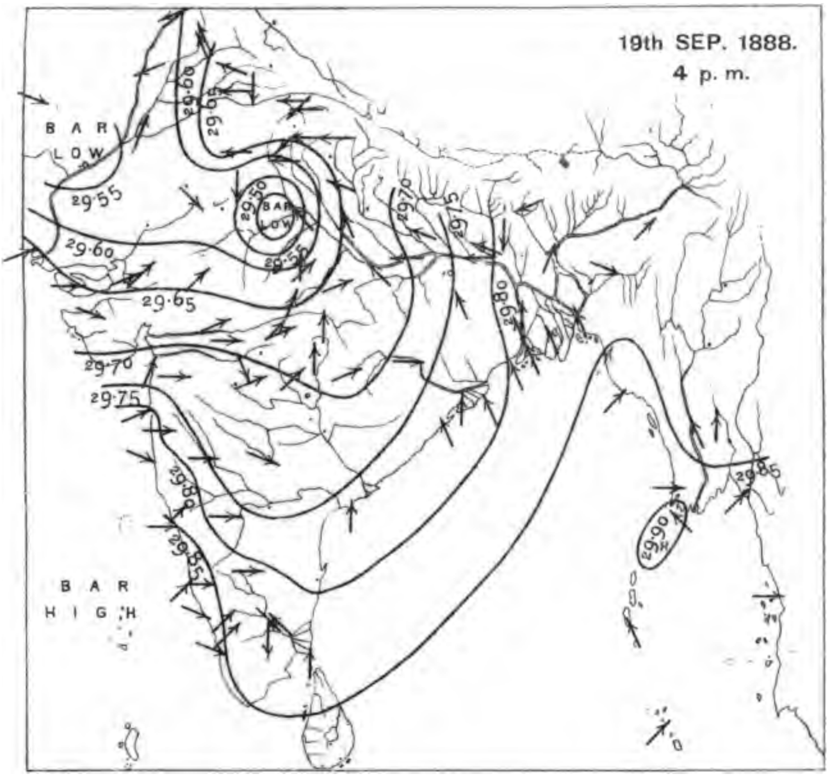
29·55
29·60
29·65
29·70
29·75
29·80
29·85
29·90
29·95
30·00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4 p. m.
BAR LOW
BAR LOW
BAR HIGH
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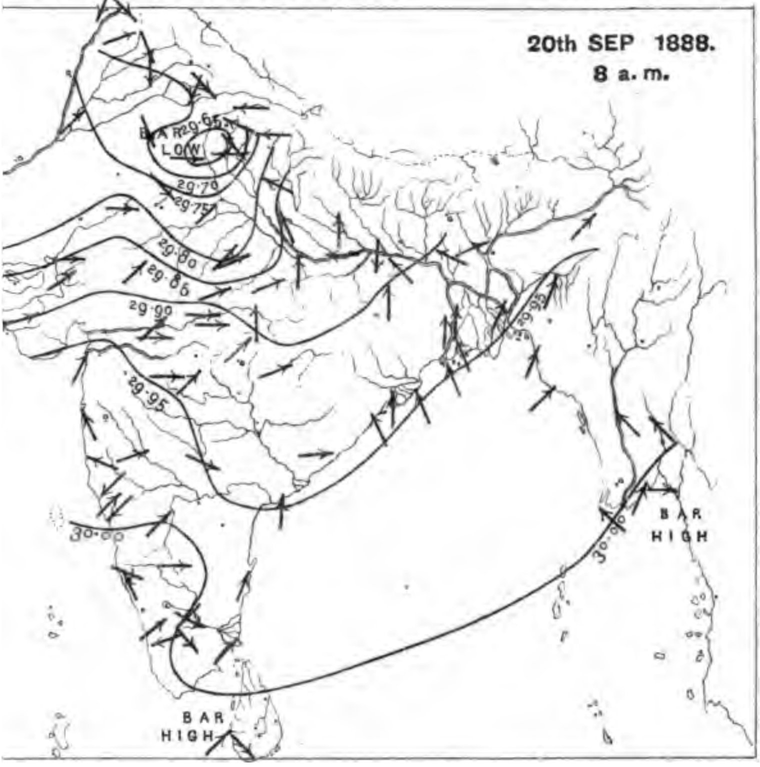

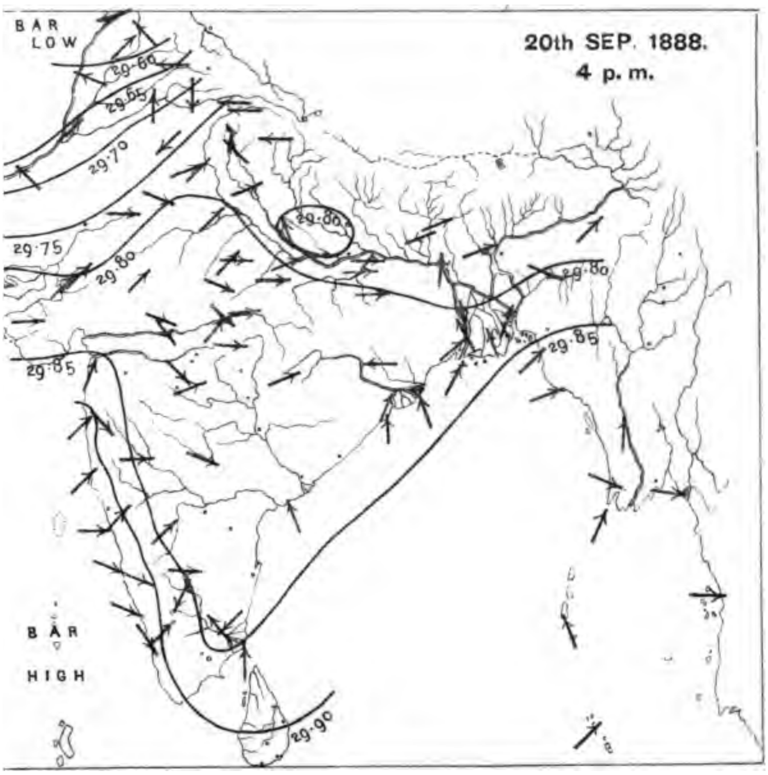

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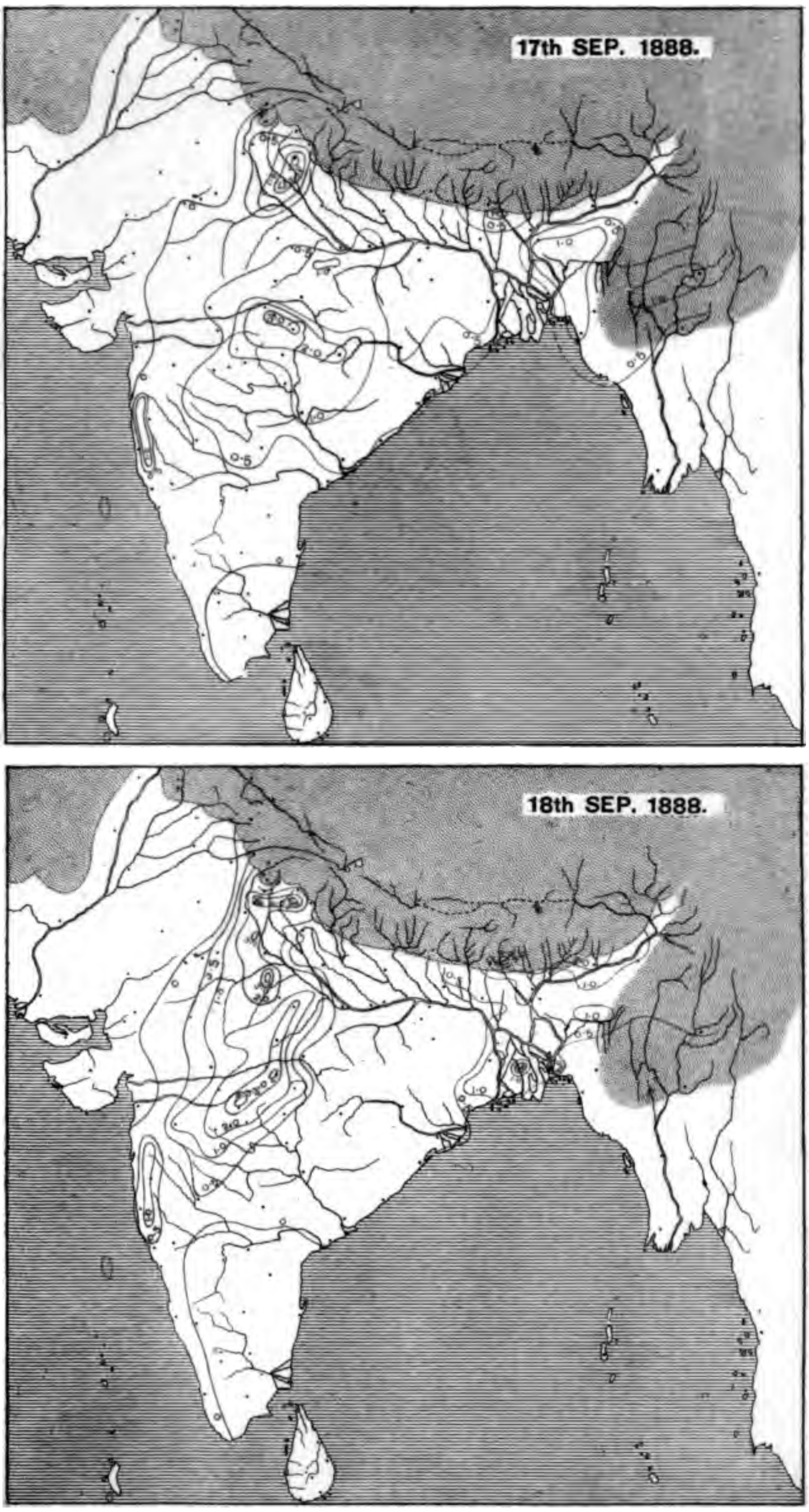

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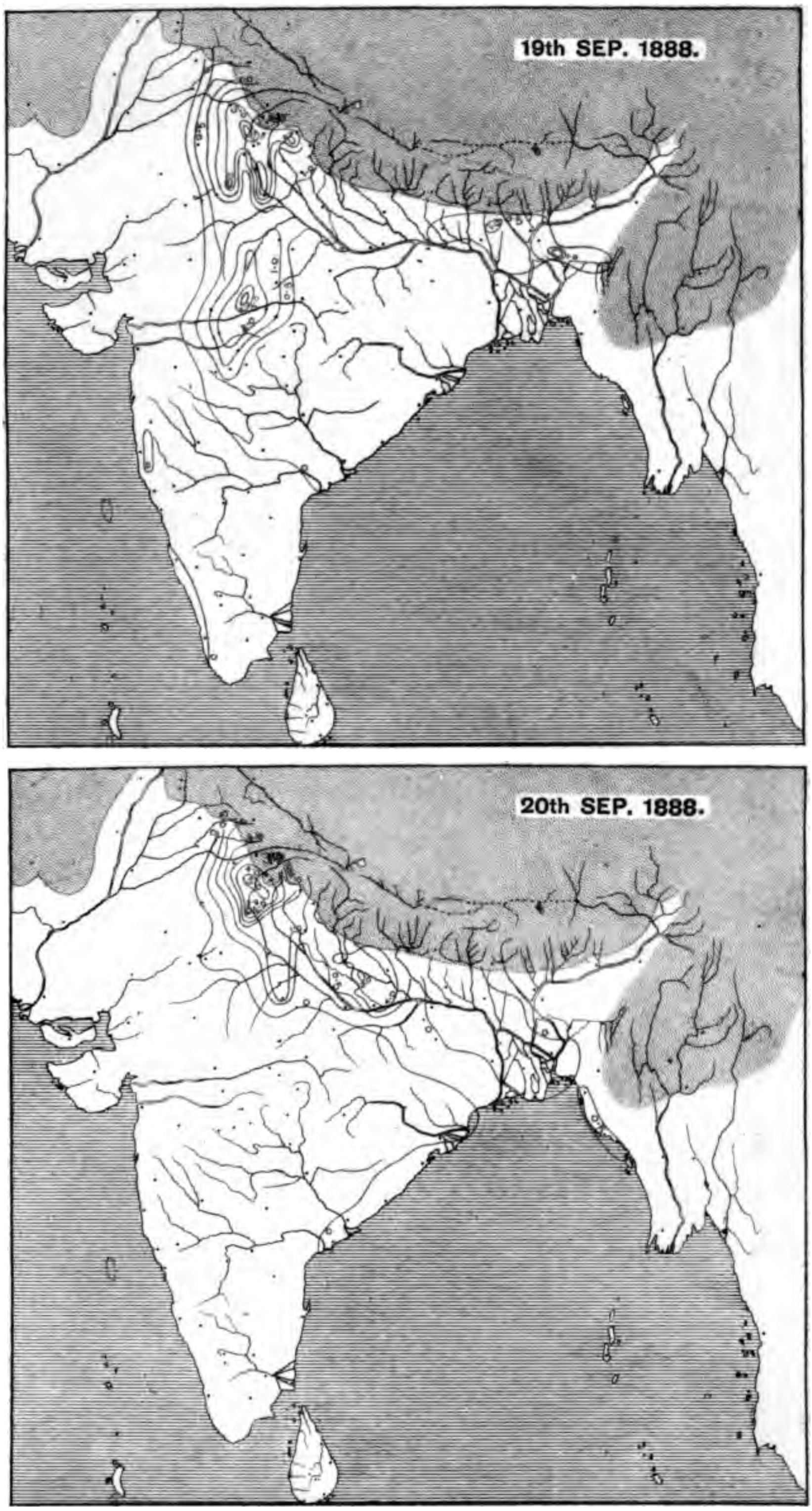

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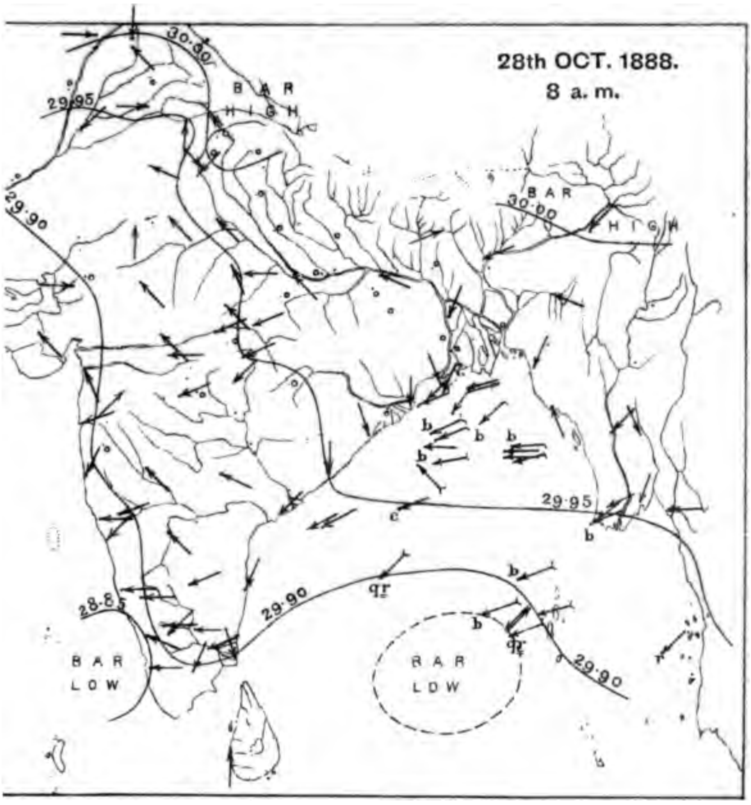

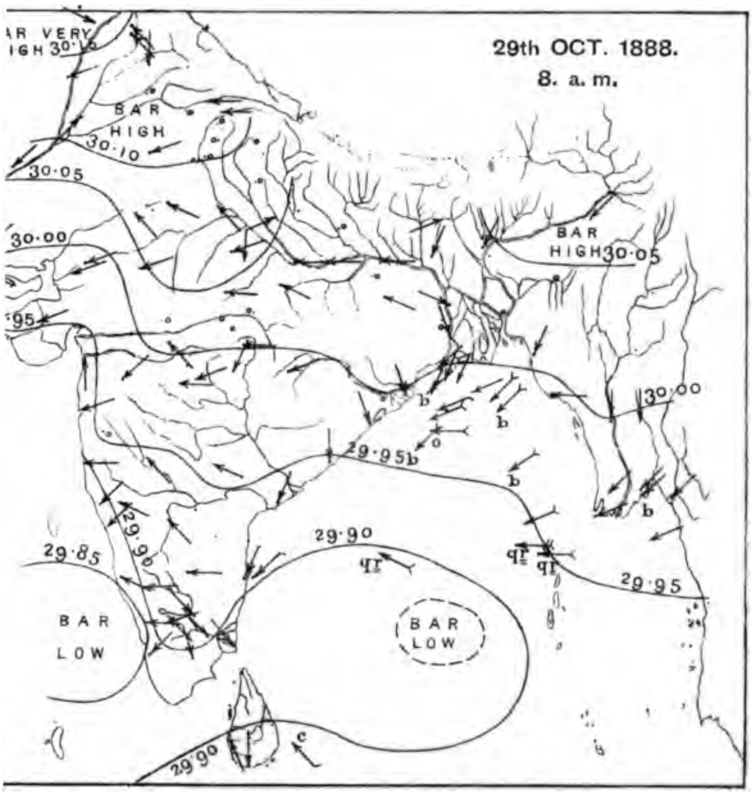

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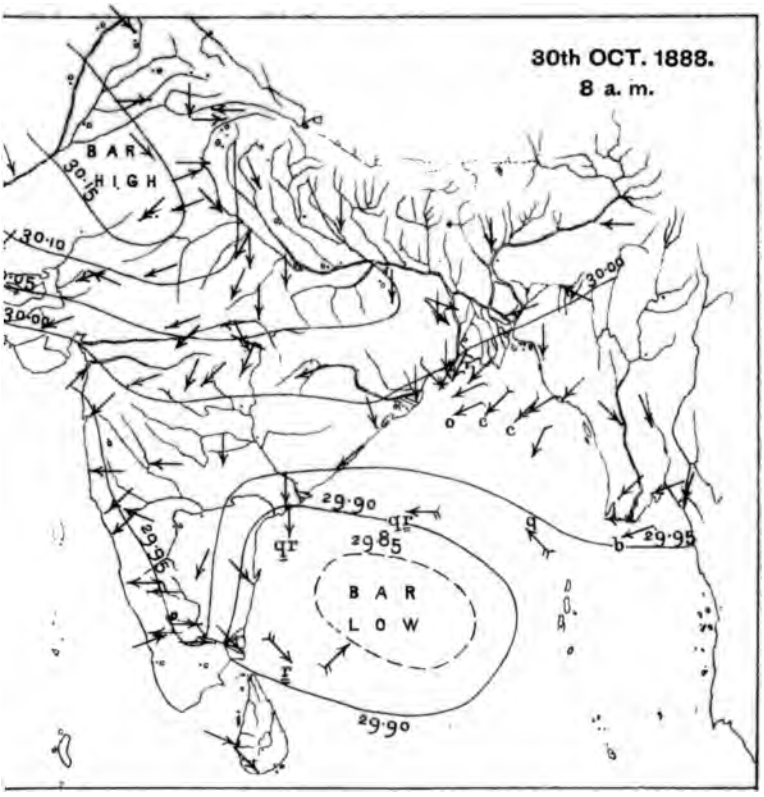

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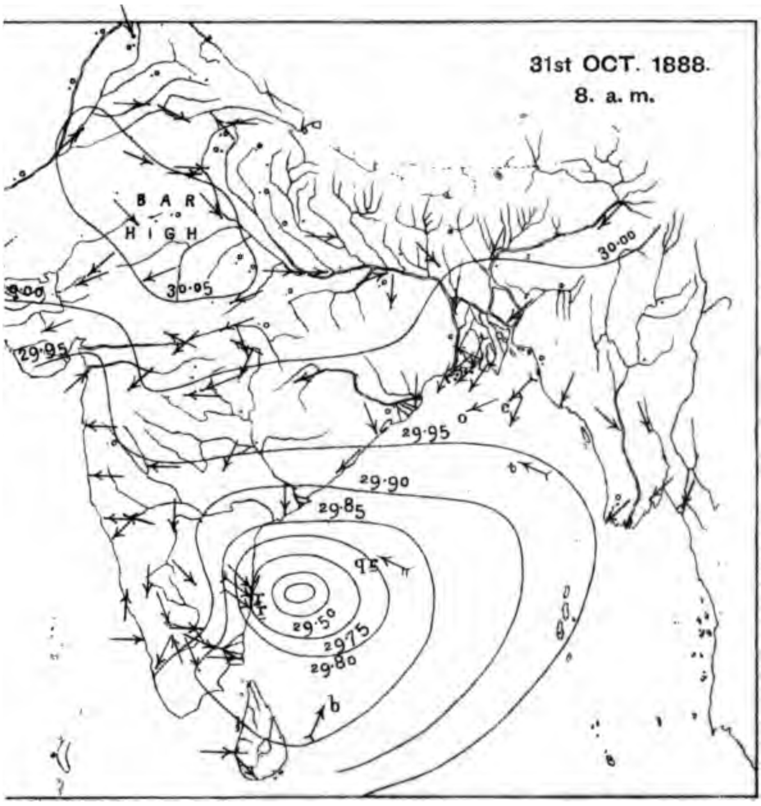

31st OCT. 1888.
8. a.m.

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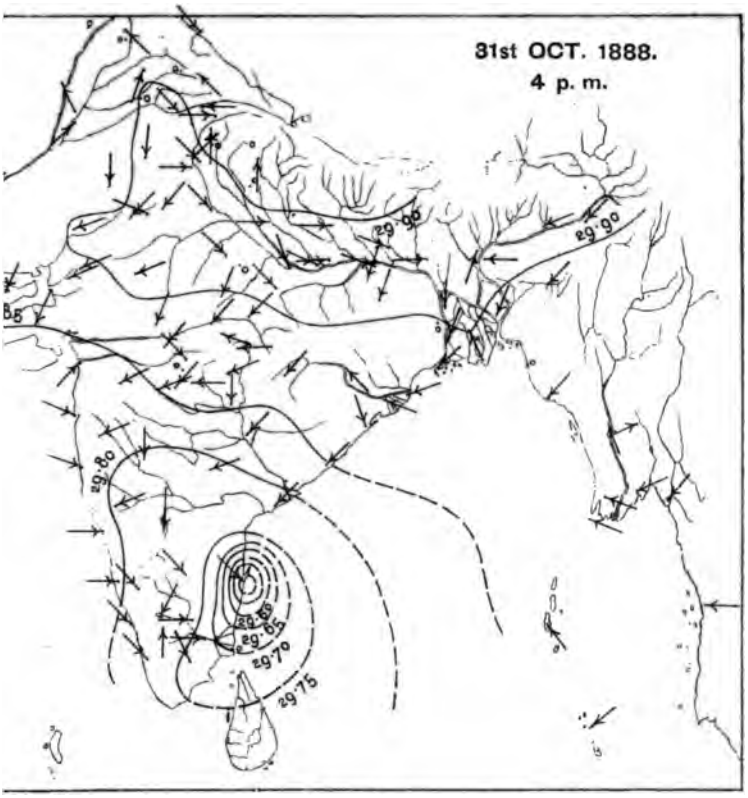

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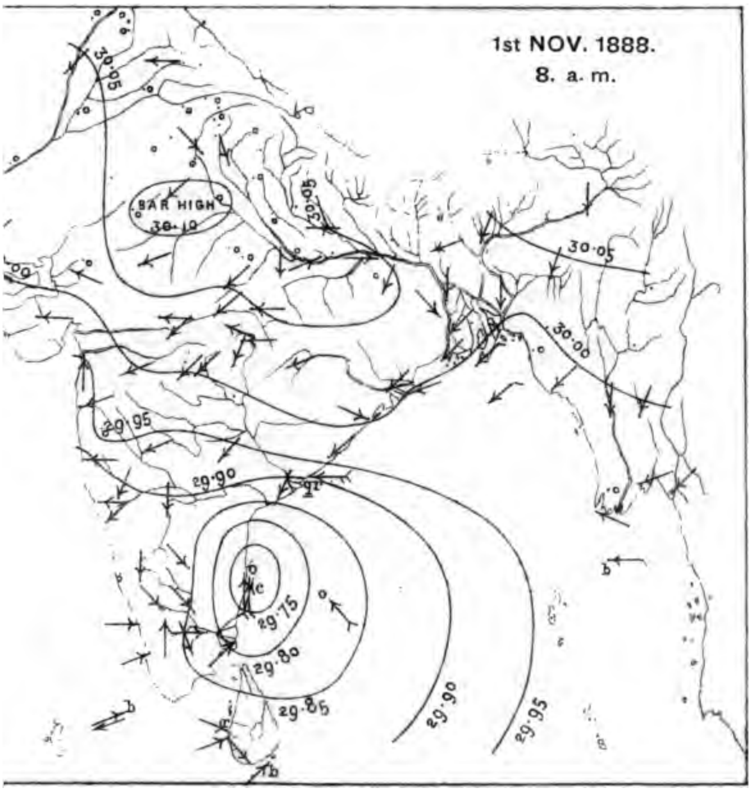

1st NOV. 1888.
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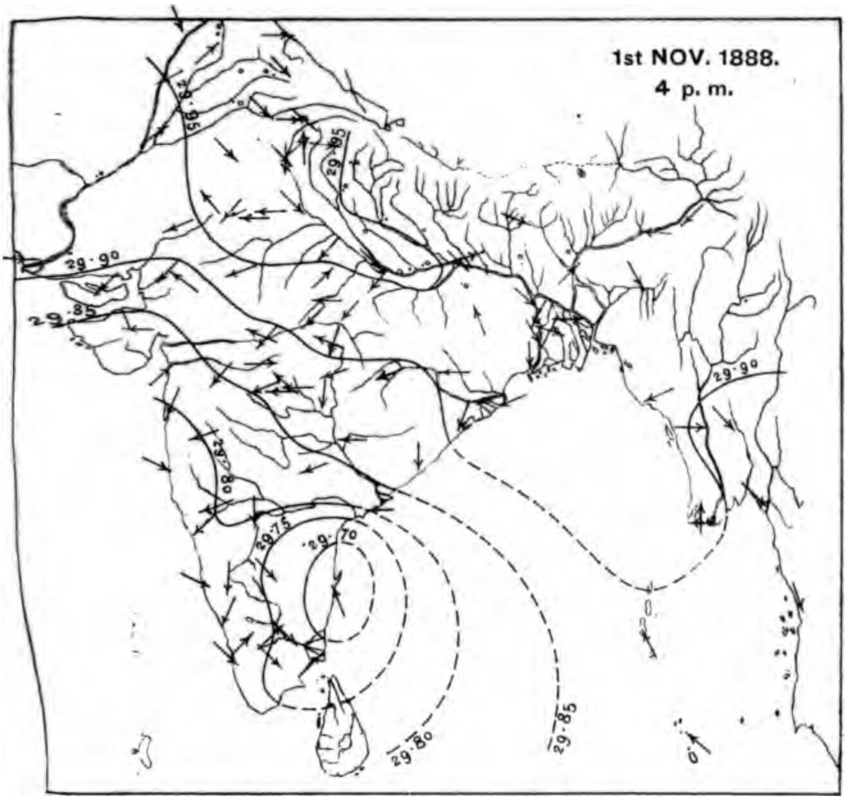

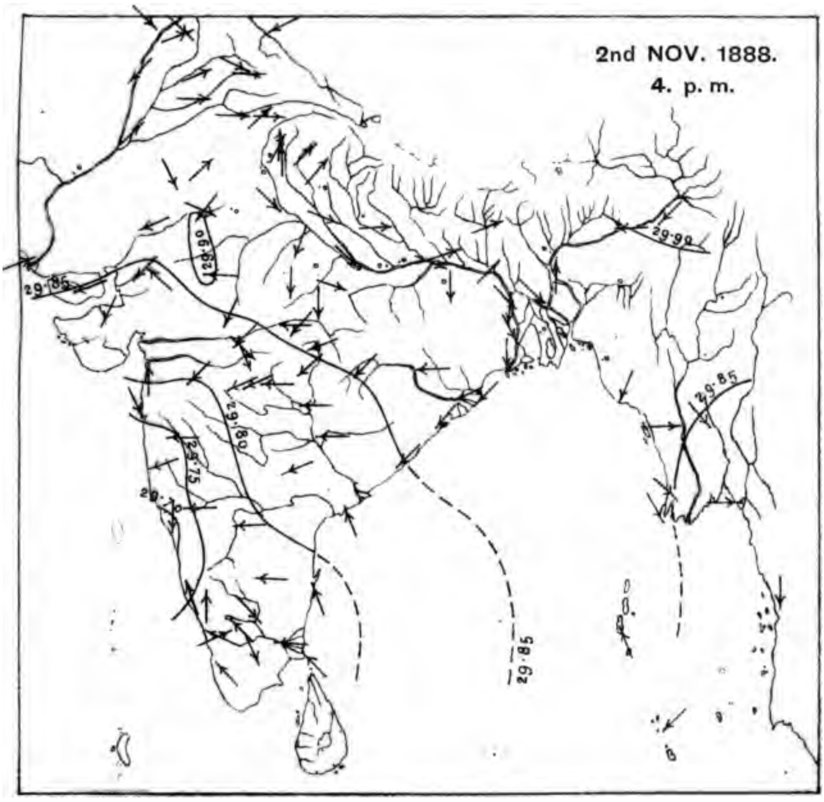

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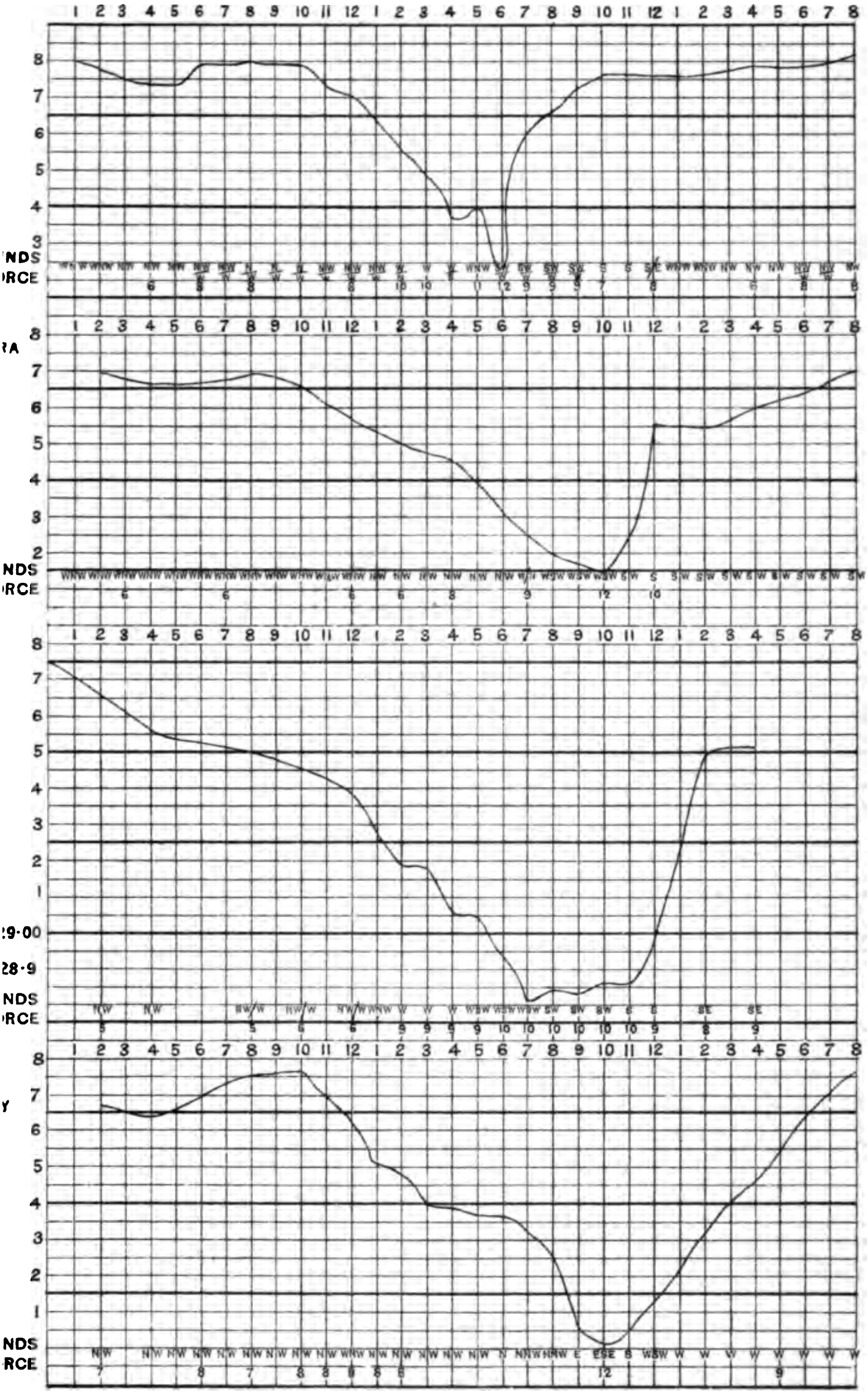
Cyclone Memoirs No. III. Plate XXXIV.



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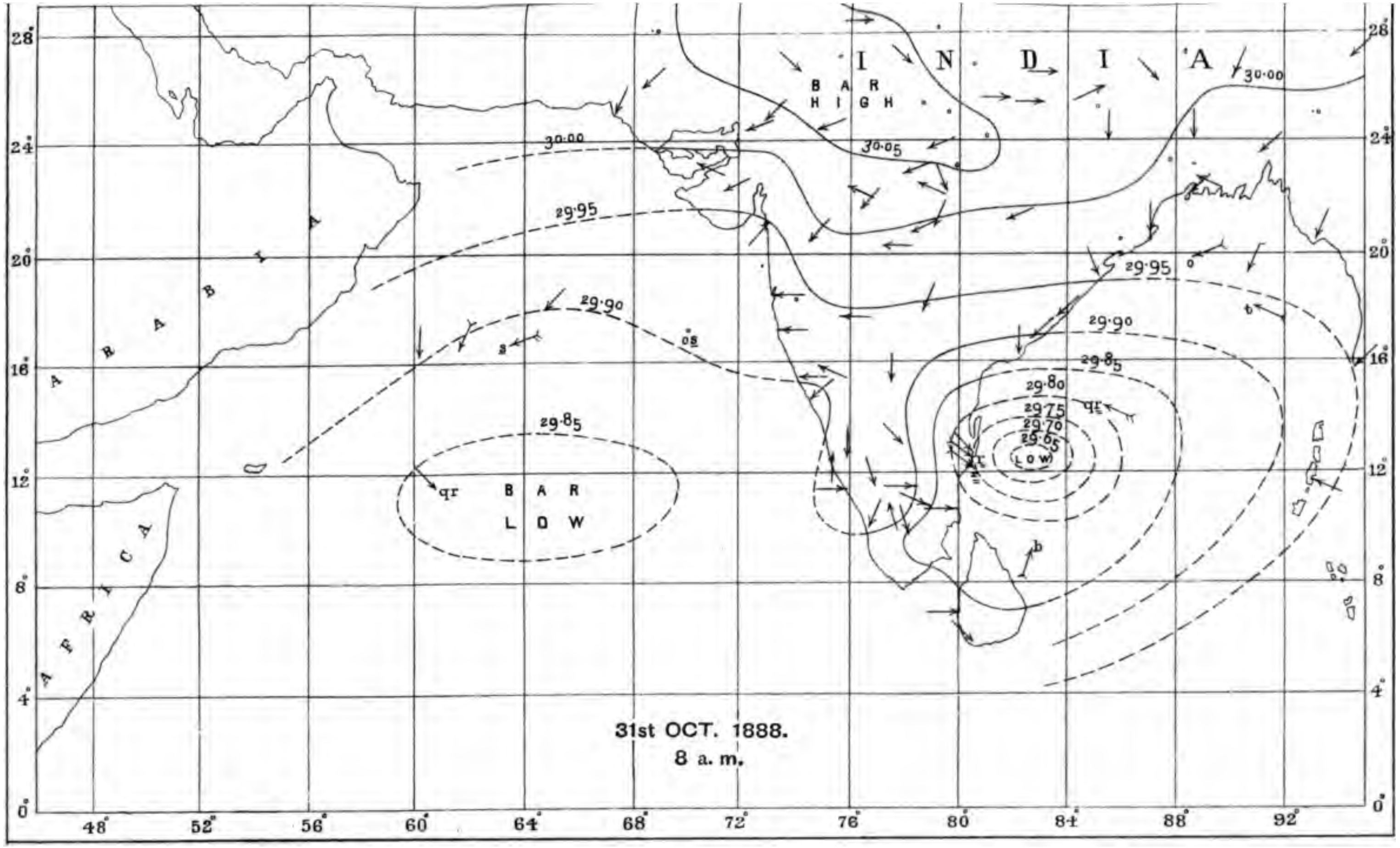

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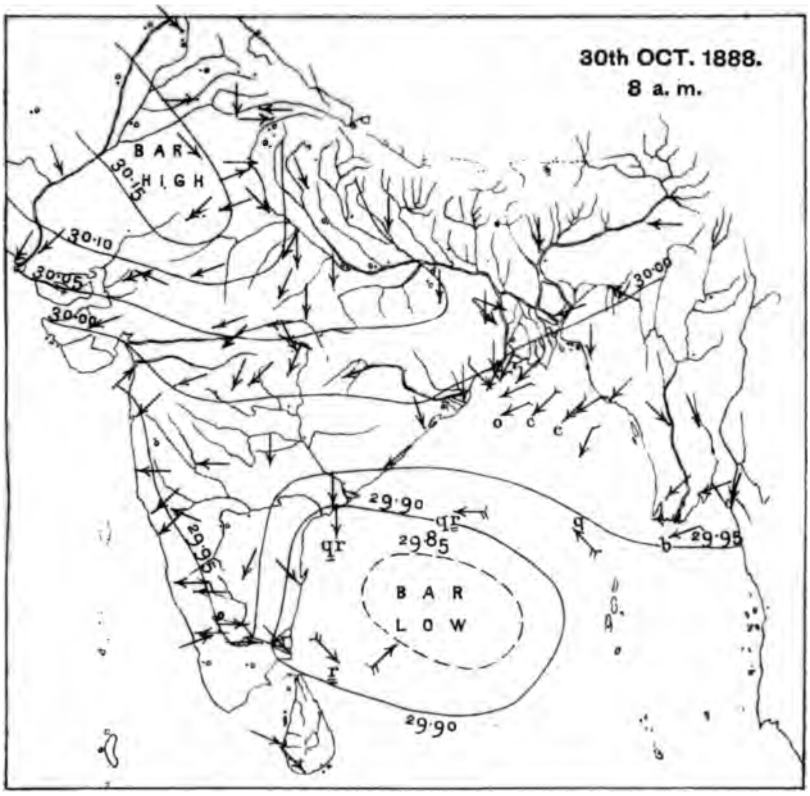

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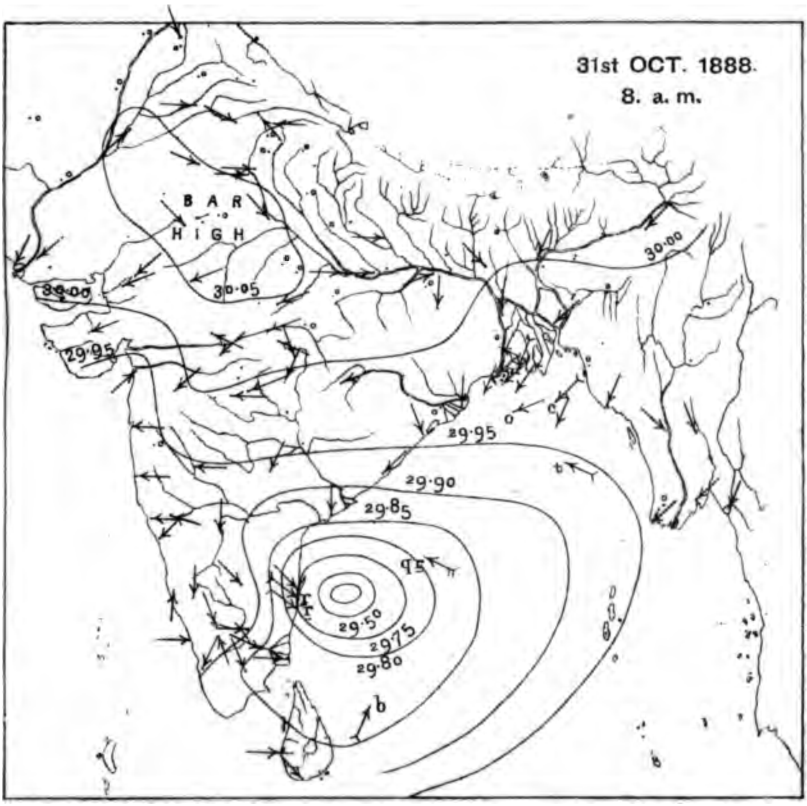

31st OCT. 1888.
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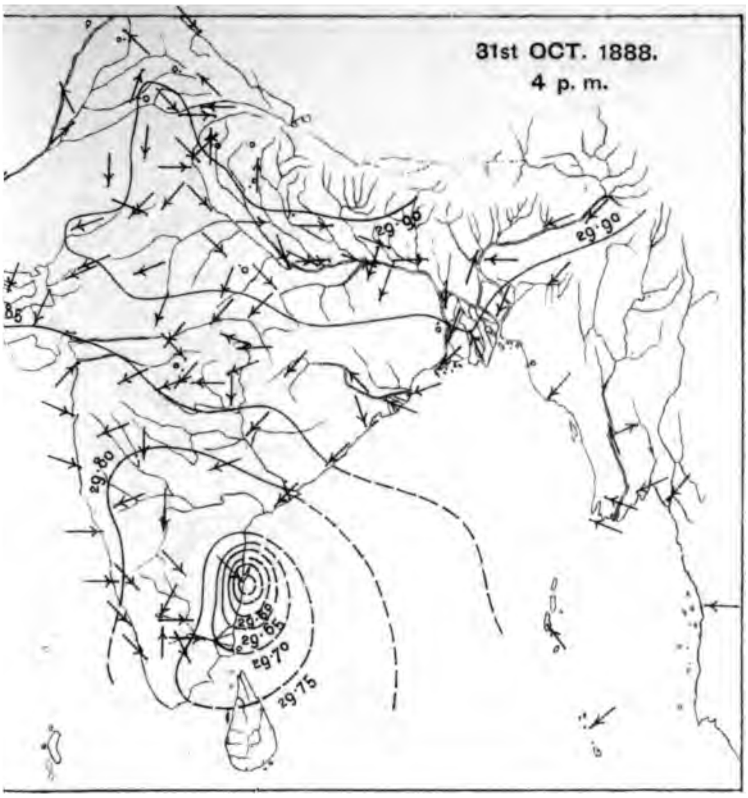
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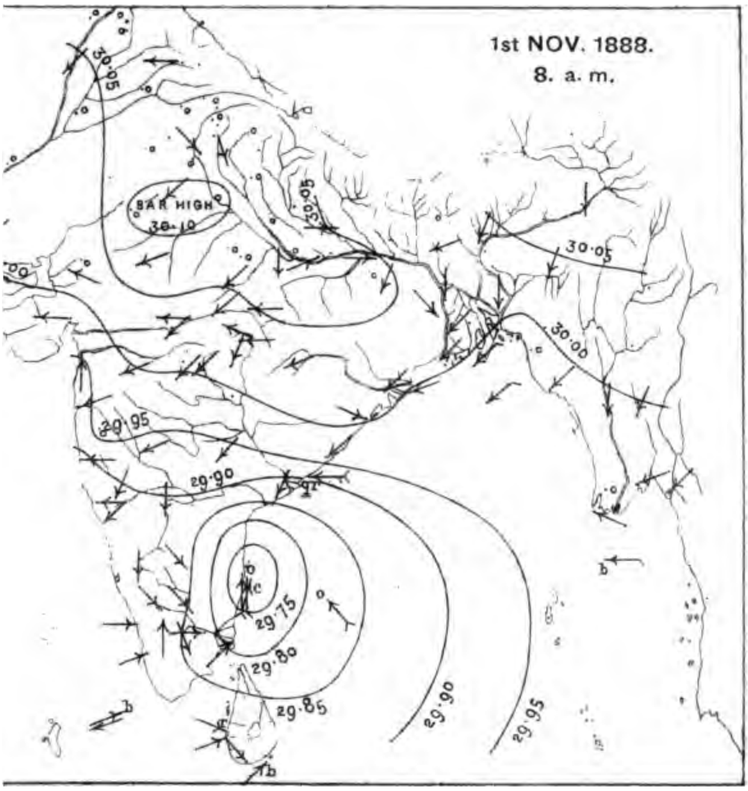
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8. a. m.

No. 74, Wr., I.—12 7-90.—465. Litho., S. I. O.,—Calcutta.

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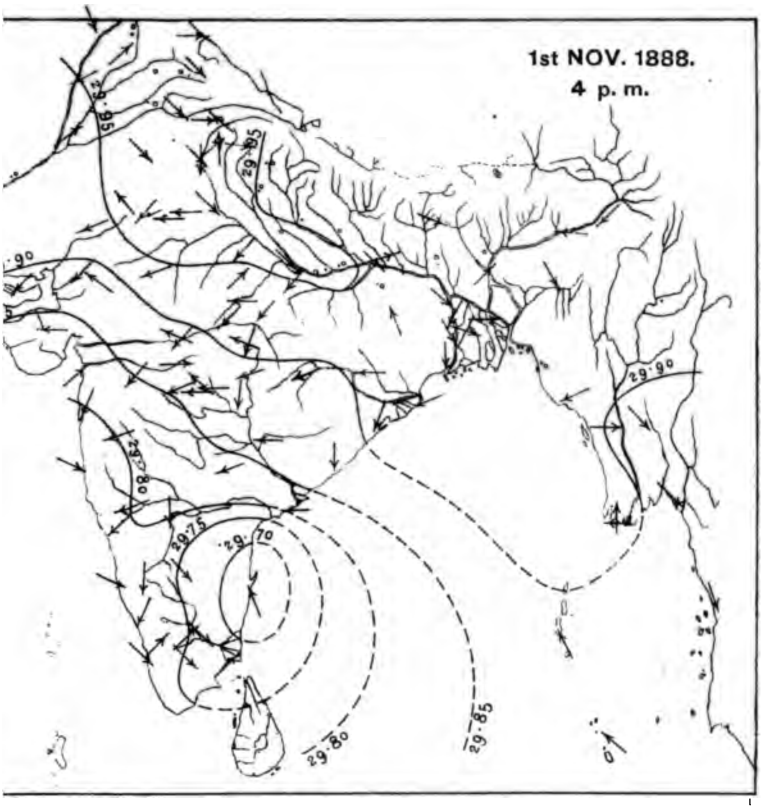
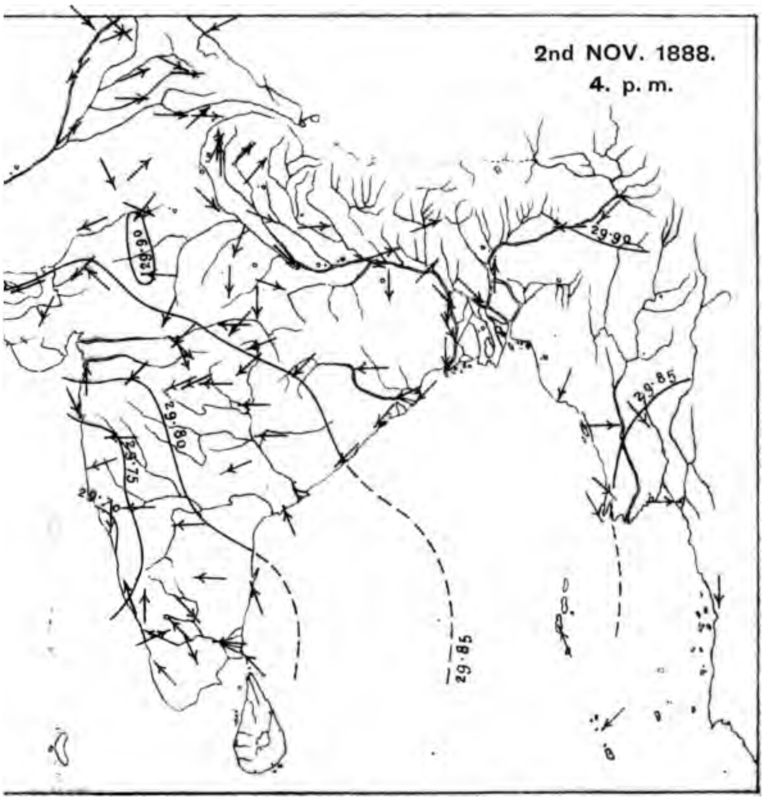
TILDEN FOUNDATIONS

'clone Memoirs No. III. Plate XXXIII.



1st NOV. 1888.
4 p.m.



2nd NOV. 1888.
4. p.m.

No. 74, Wr., I.—12 7-90.—465.
Litho., S. I. O.,—Calcutta.

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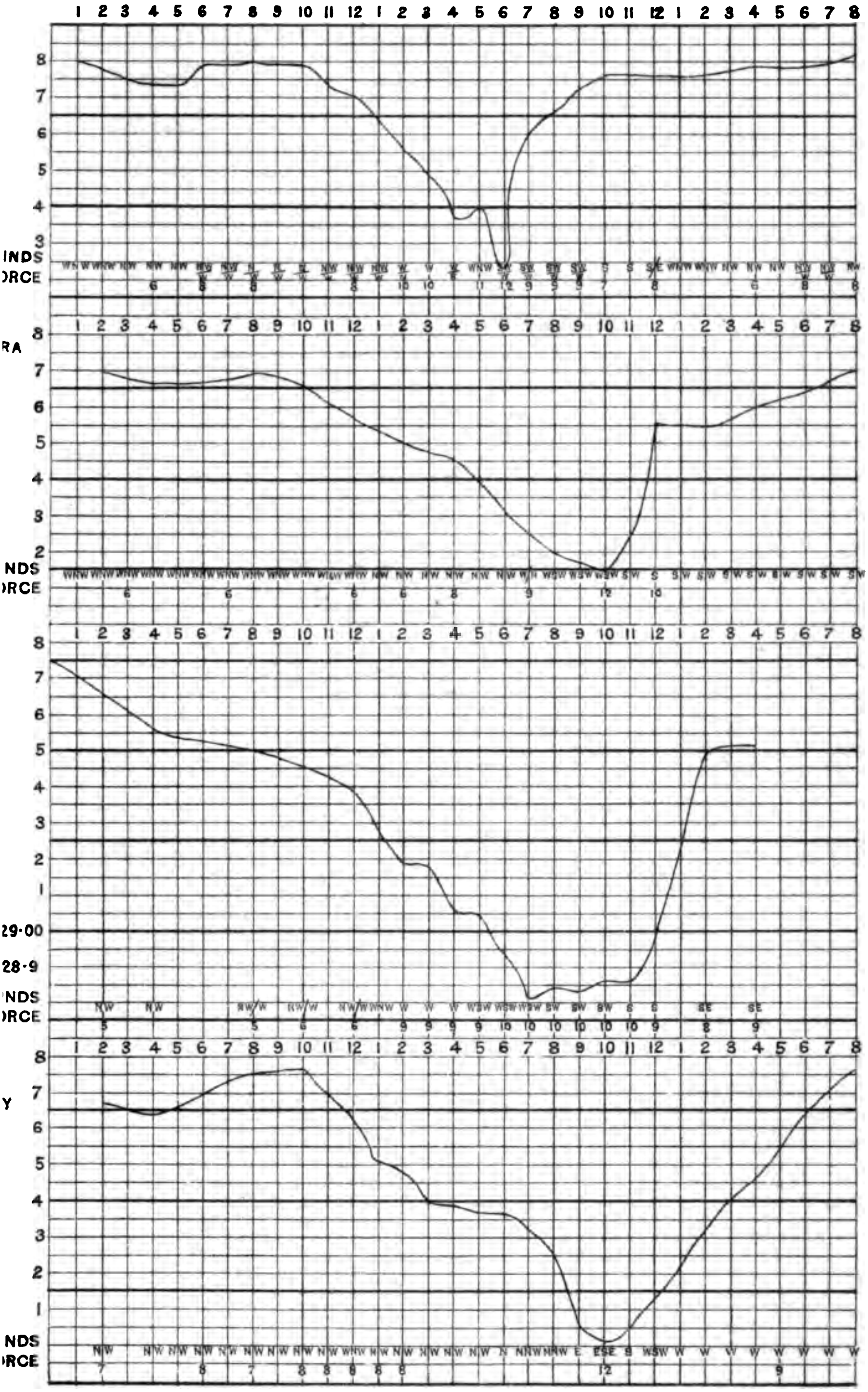
ASTOR, LENOX AND
TILDEN FOUNDATIONS.

Cyclone Memoirs No. III. Plate XXXIV.



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Litho., S. I. C.,—Calcutta.

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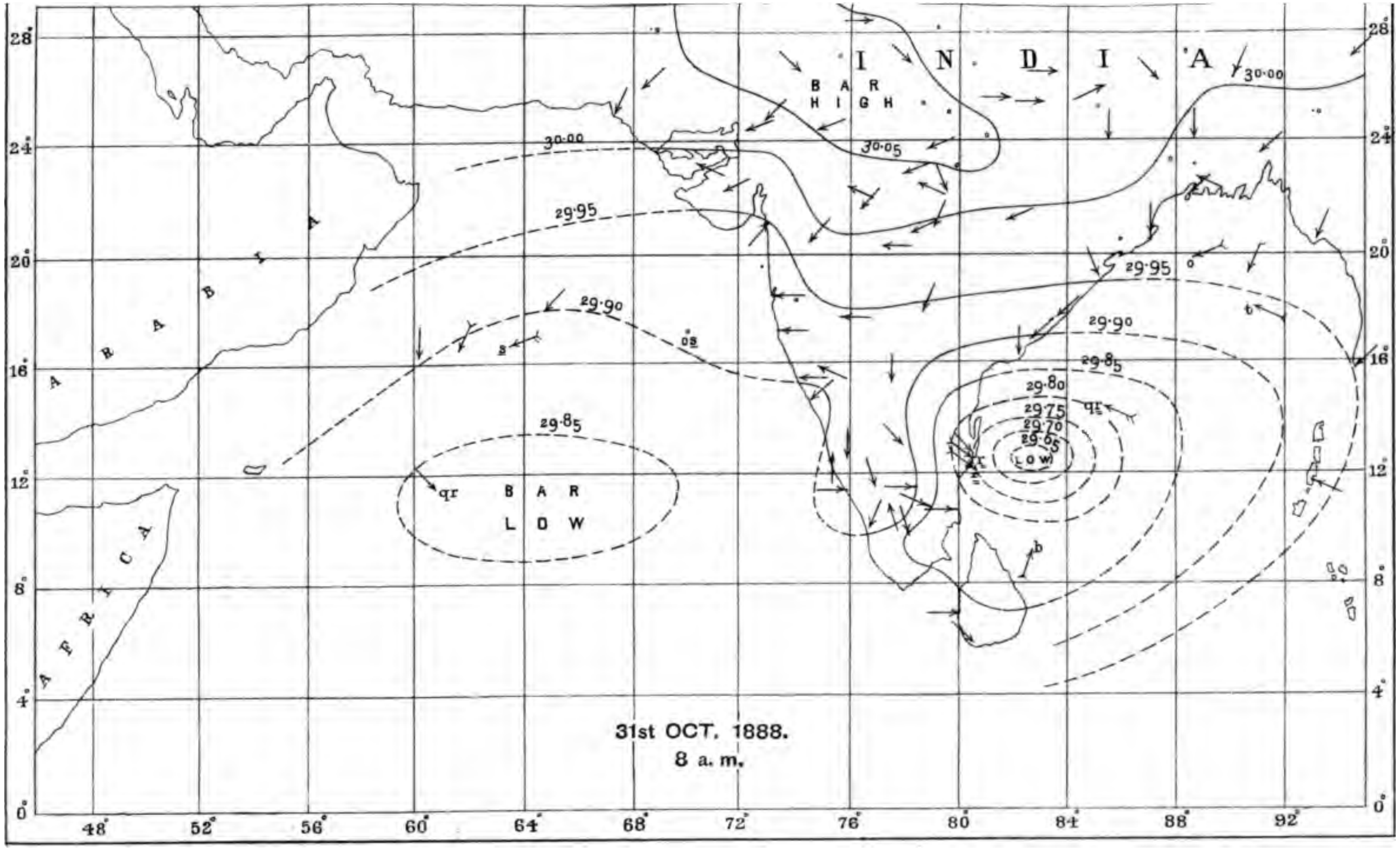

31st OCT. 1888.
8 a. m.

Reg. No. 74, Wr., I.—12 7-90.—465.

Litho., S. I. O.,—Calcutta.

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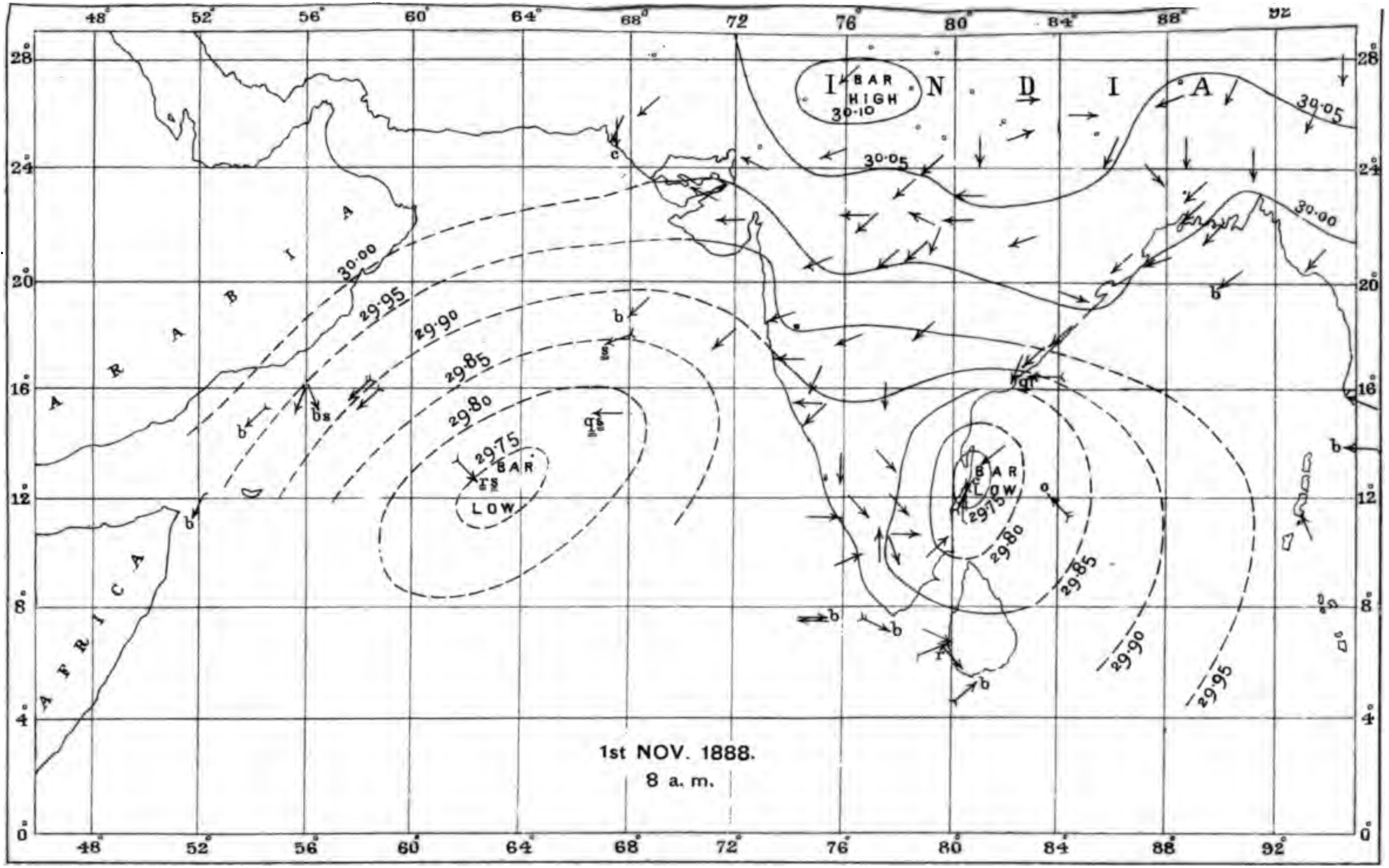
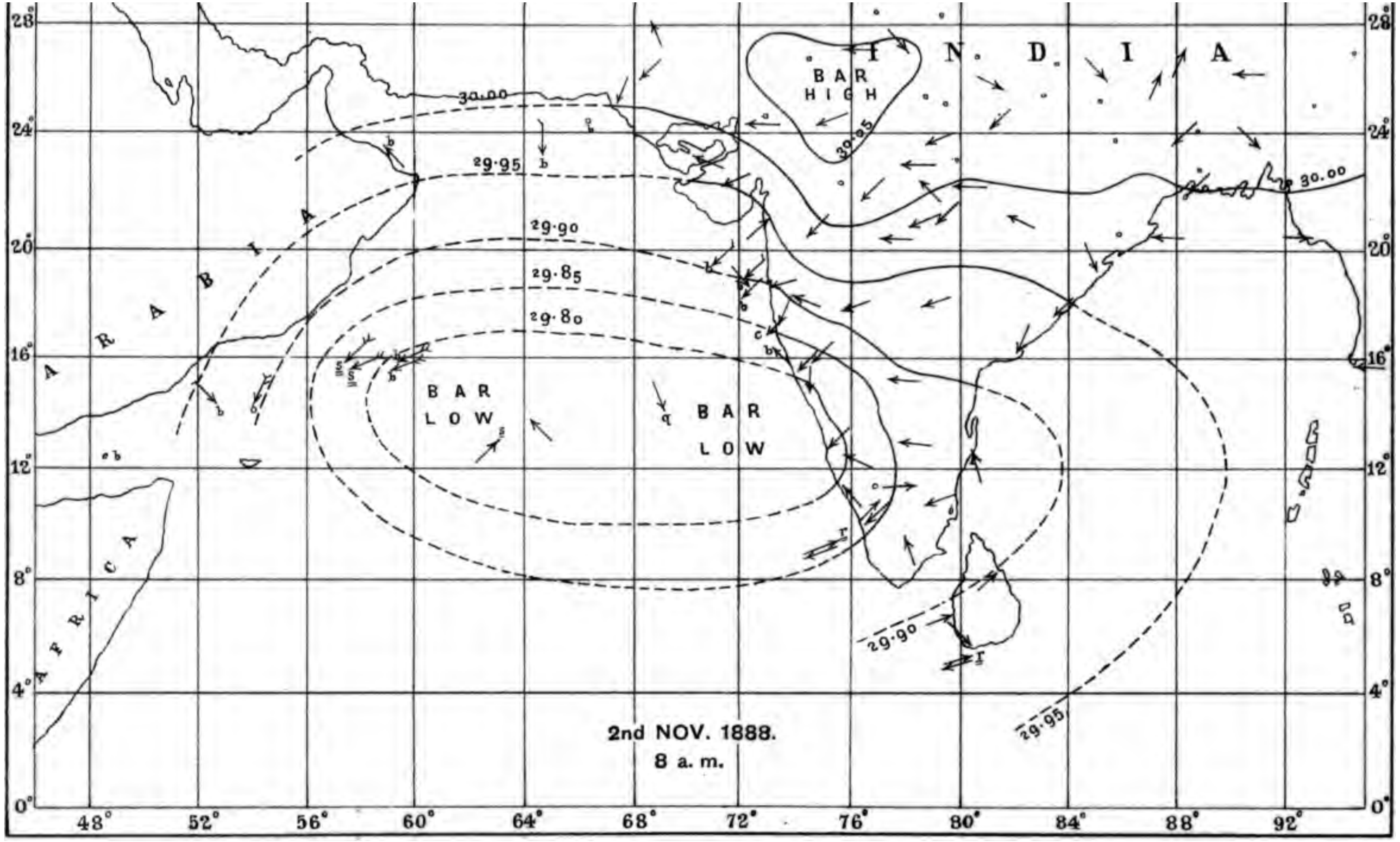


Reg. No. 74, Wr., I.—12 7-90.—465.

Litho., S. I. O.,—Calcutta.

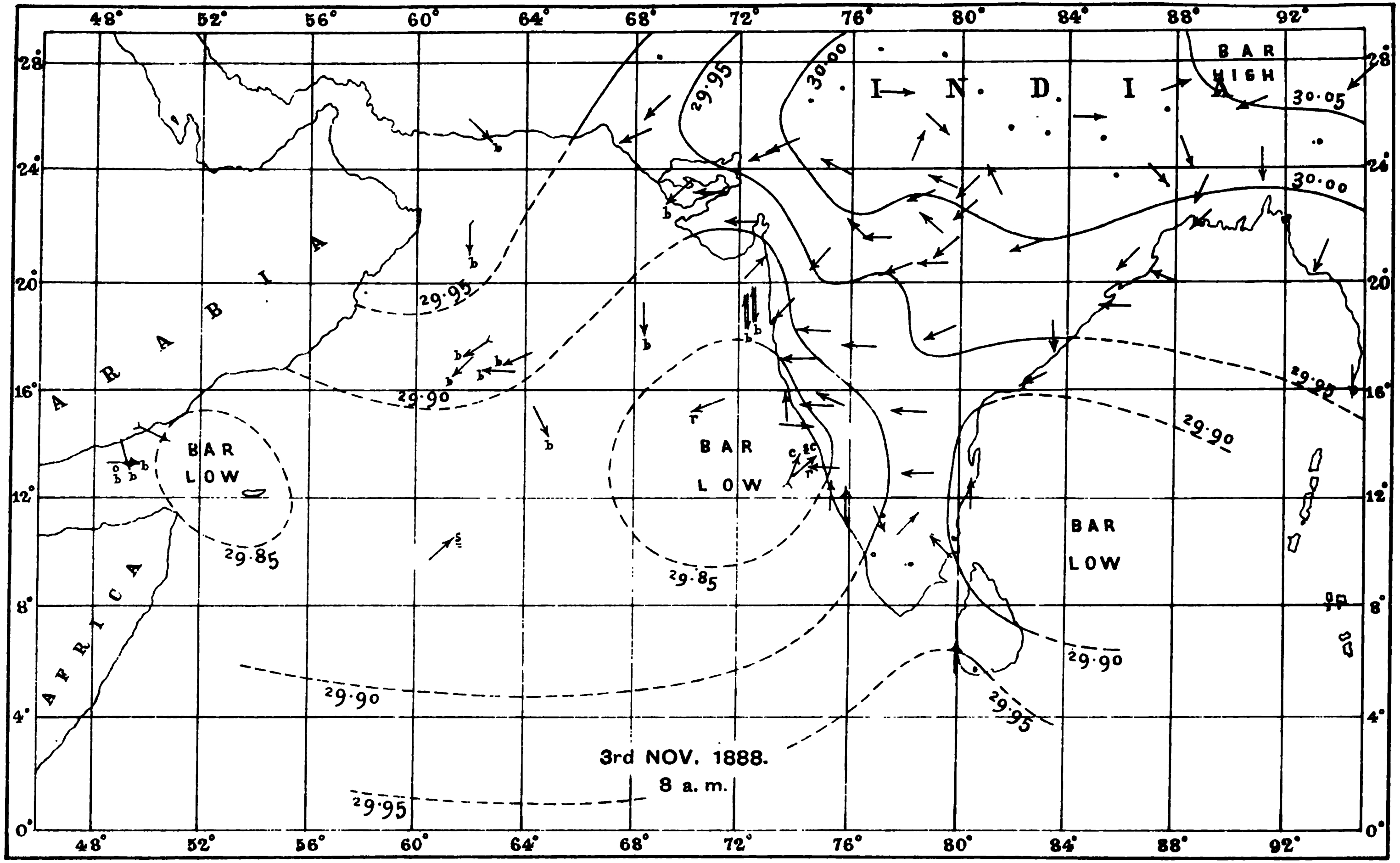


2nd NOV. 1888.
8 a. m.

Reg. No. 74, Wr., I.—12 7-90.—465.

Litho., S. I. O.,—Calcutta.

Plate XXXVIII.



Reg. No. 74, Wr., I.—12 7-90.—465.

Litho., S. I. O.,—Calcutta.

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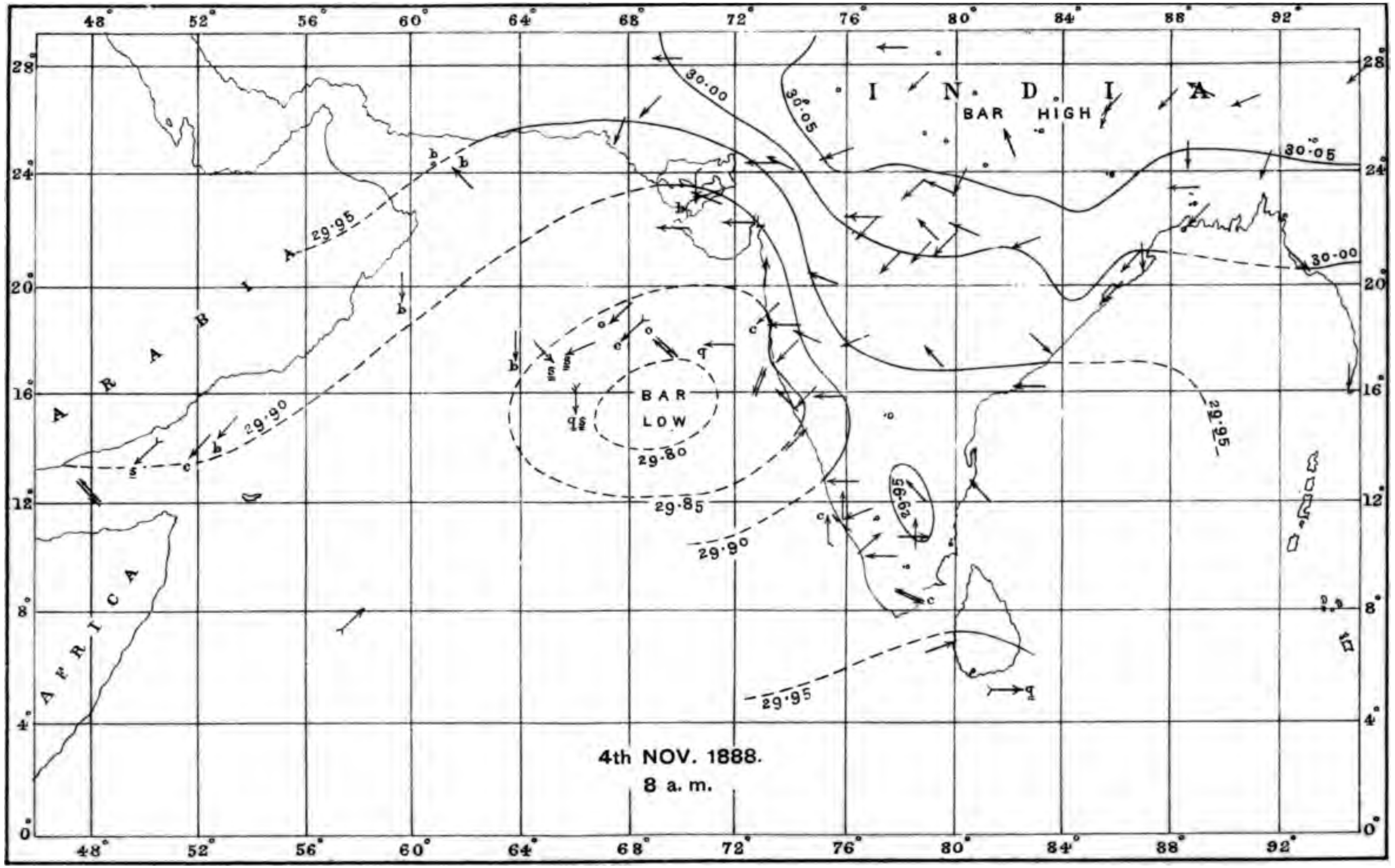
TILDEN FOUNDATIONS



4th NOV. 1888.
8 a.m.

Reg. No. 74, Wr., I.—12 7-90.—465.

Litho., S. I. O.,—Calcutta.

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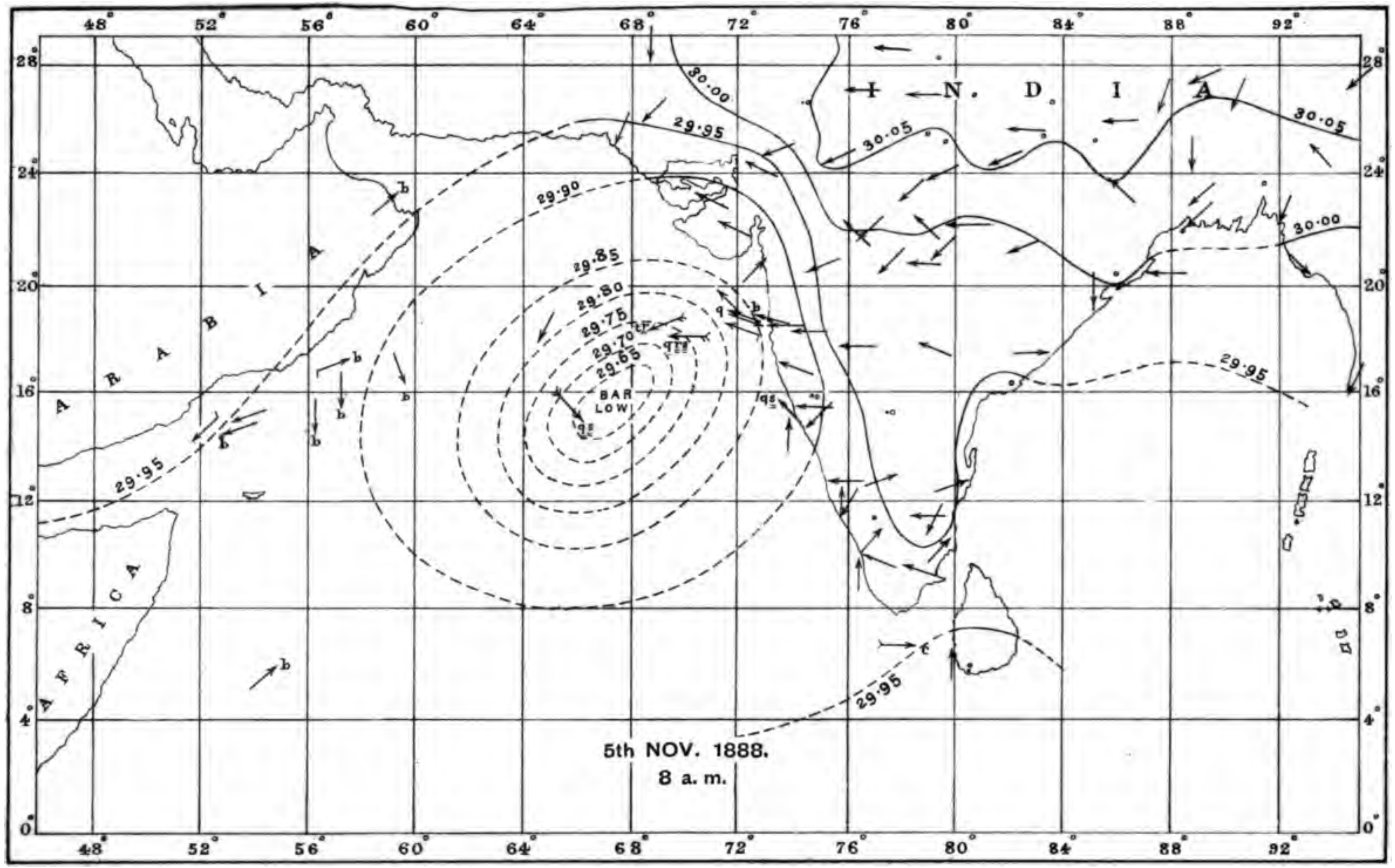
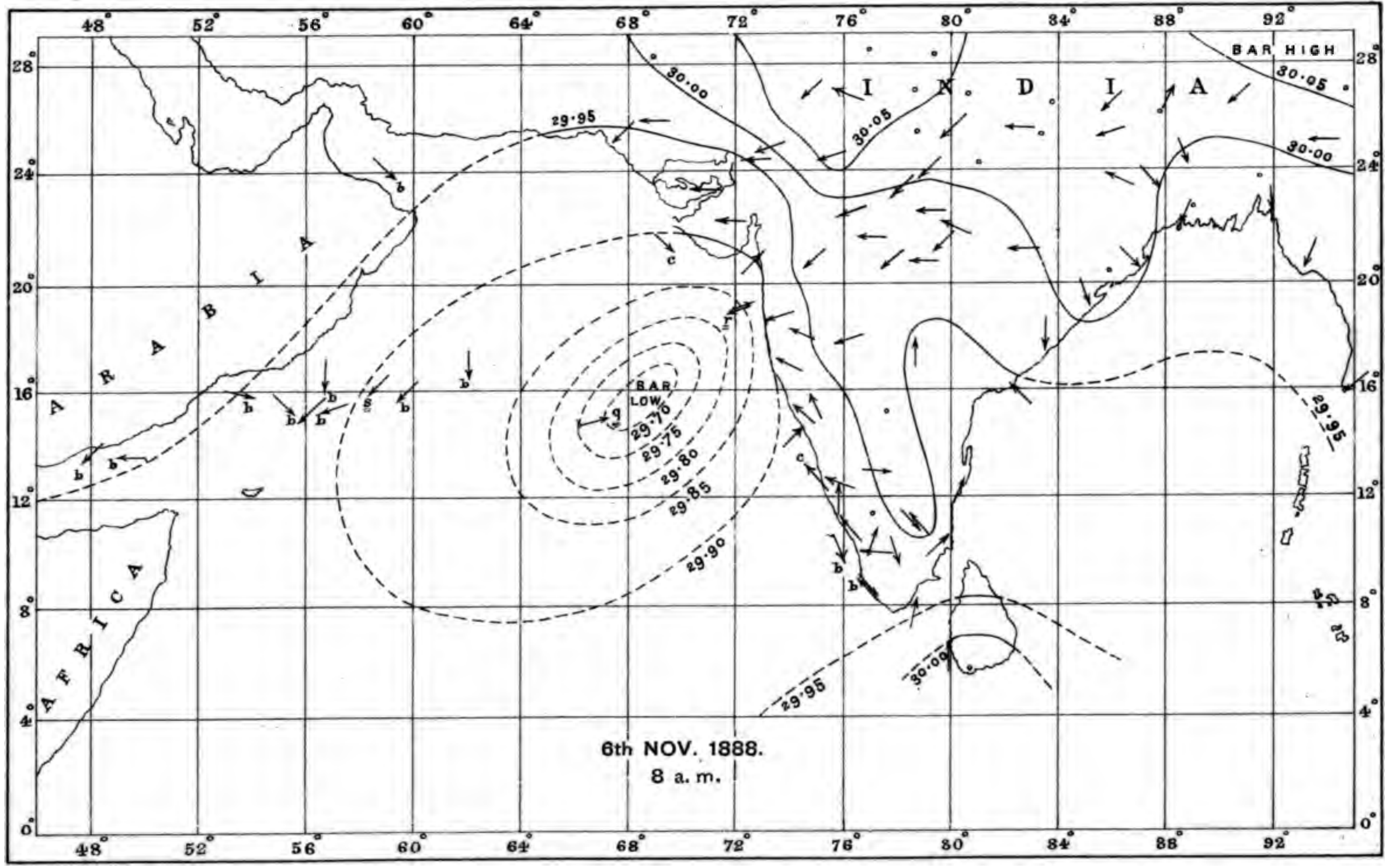
TILDEN FOUNDATIONS



5th NOV. 1888.
8 a.m.

Reg. No. 74, Wr., I.—12 7-90.—465.

Litho., S. I. O.—Calcutta.


6th NOV. 1888.
8 a.m.
BAR HIGH
BAR LOW
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A R A B I A
A F R I C A
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30·00
29·95
29·90
29·85
29·80
29·75
29·70
48°
52°
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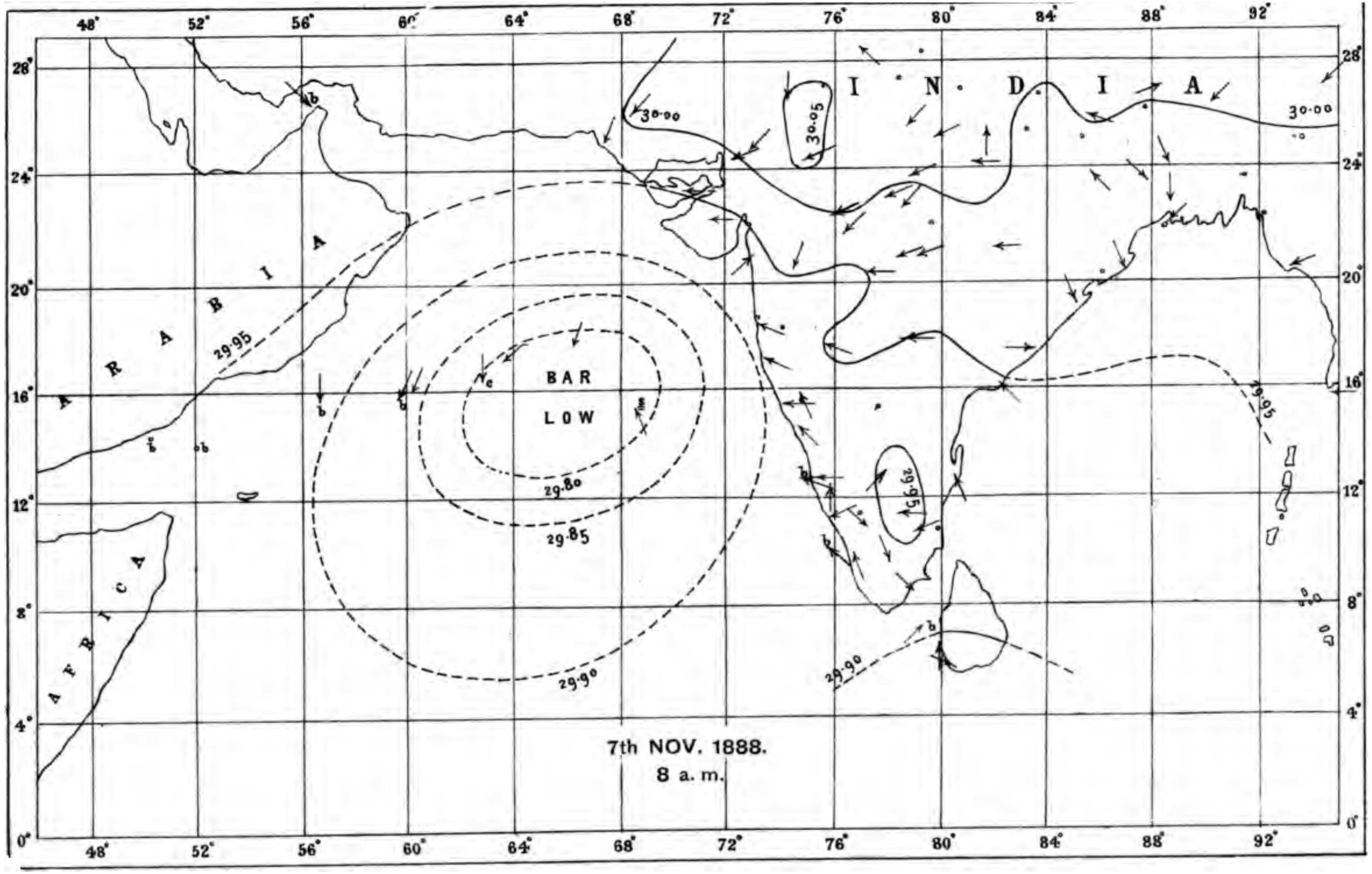

7th NOV. 1888.
8 a. m.

Reg. No. 74, Wr., I.—12 7-90.—465.

Litho., S. I. O.,—Calcutta.

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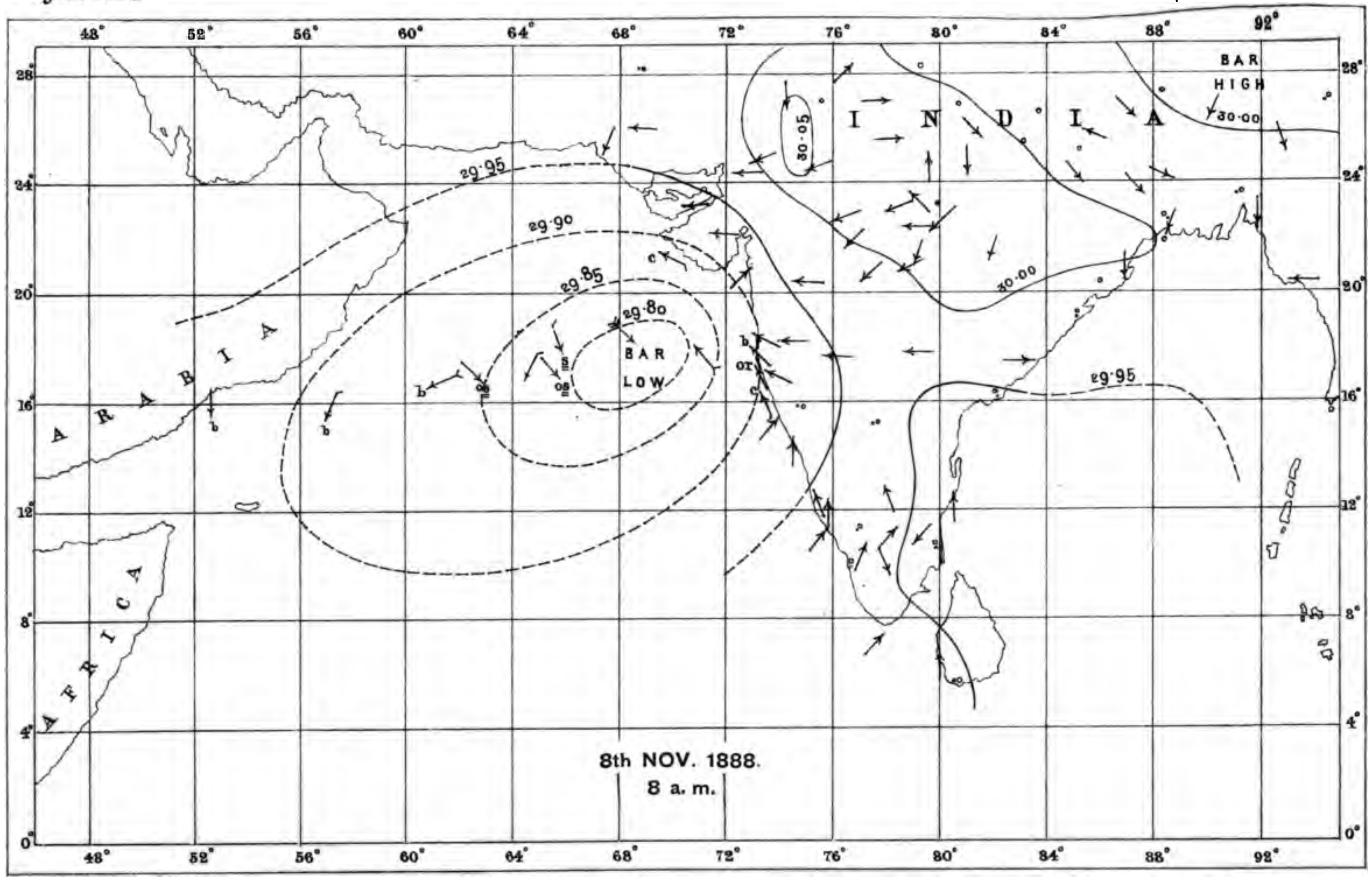
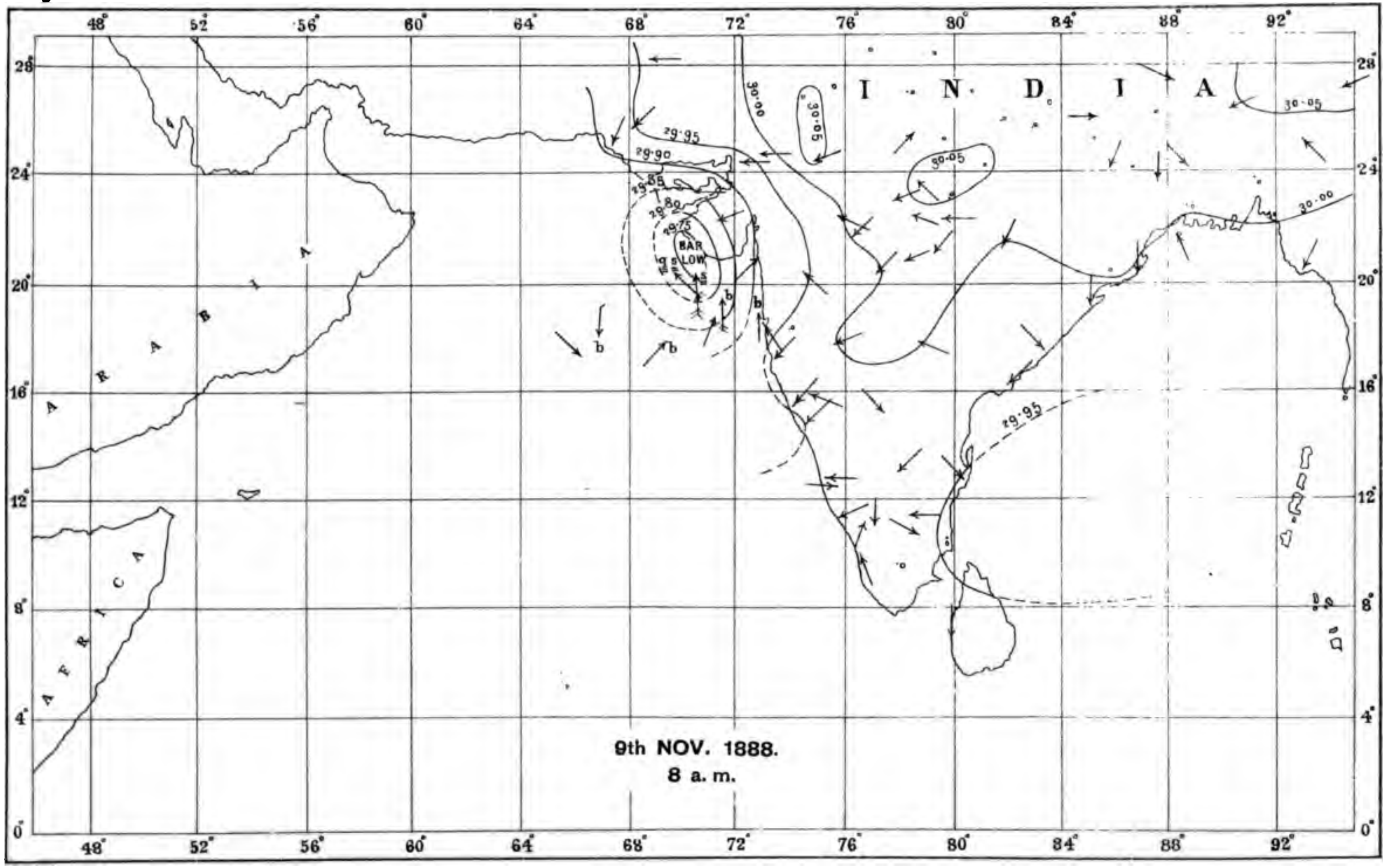
TILDEN FOUNDATIONS.



Reg. No. 74, Wr., I.—12 7-90.—465.

Litho., S. I. O.,—Calcutta.



9th NOV. 1888.
8 a.m.

Litho., S. I. O.,—Calcutta.

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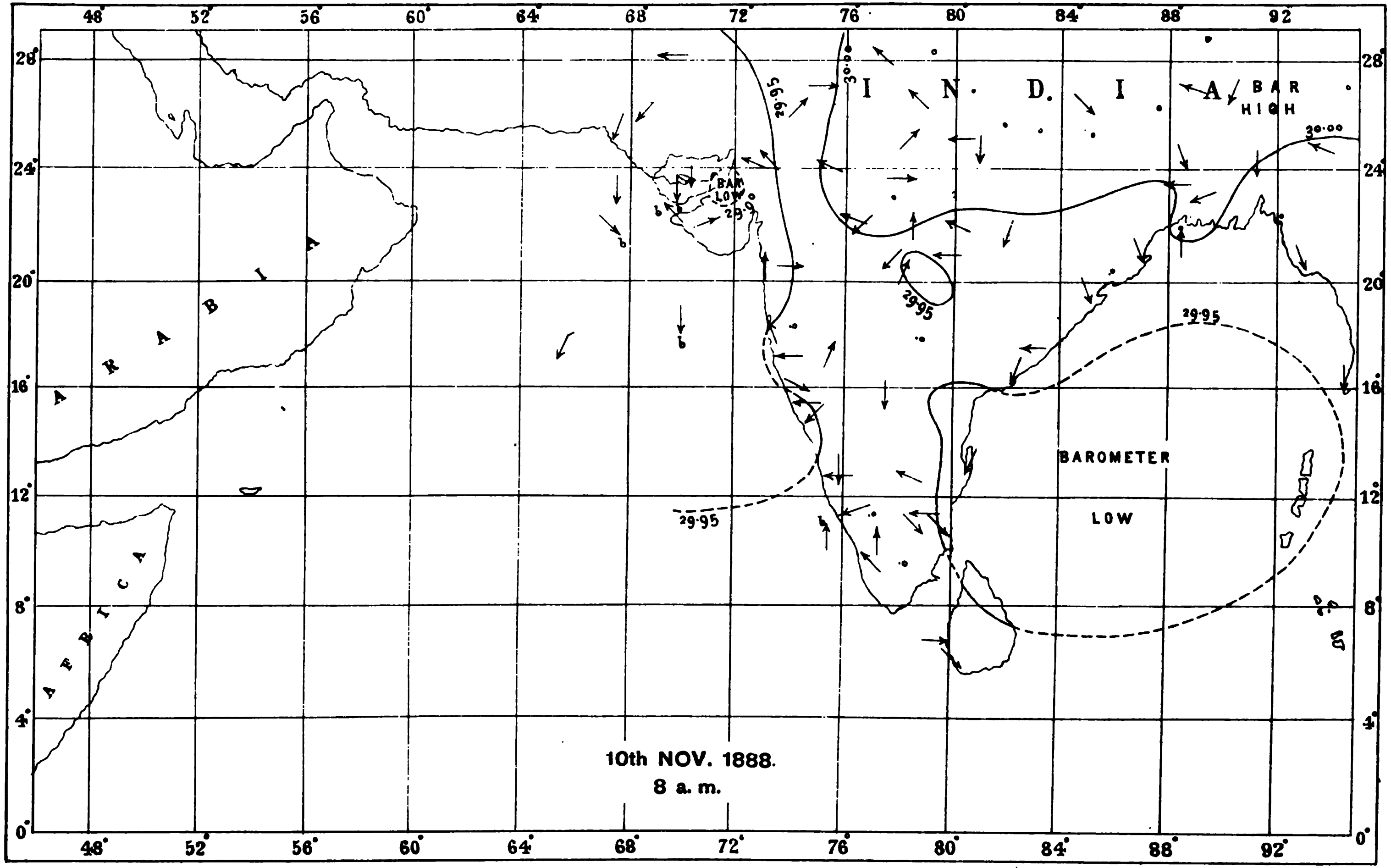
ASTOR LENOX AND
TILDEN FOUNDATIONS

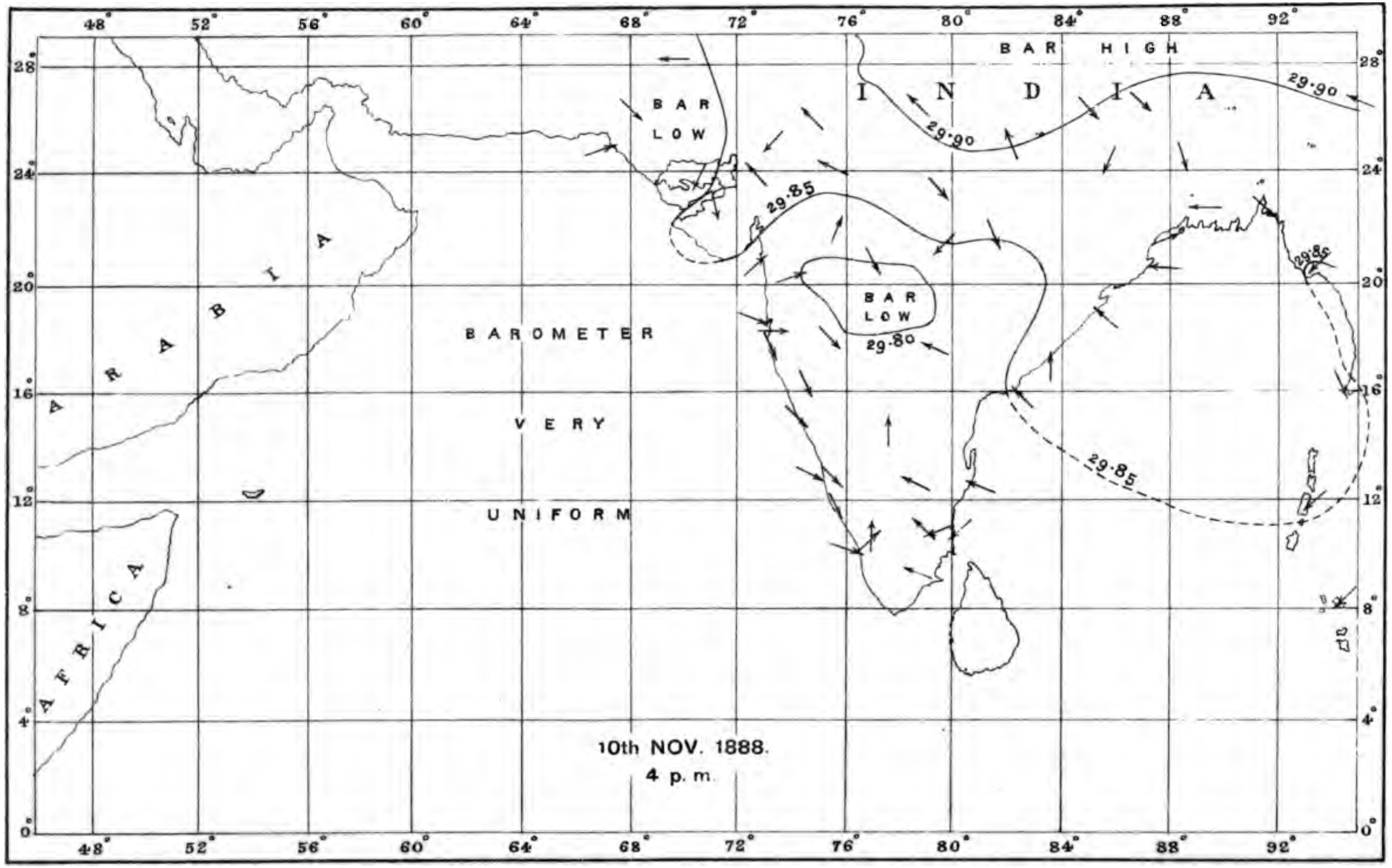


10th NOV. 1888.
8 a. m.

Reg. No. 74, Wr., I.—12 7-90.—466.

Litho., S. I. O.,—Calcutta.

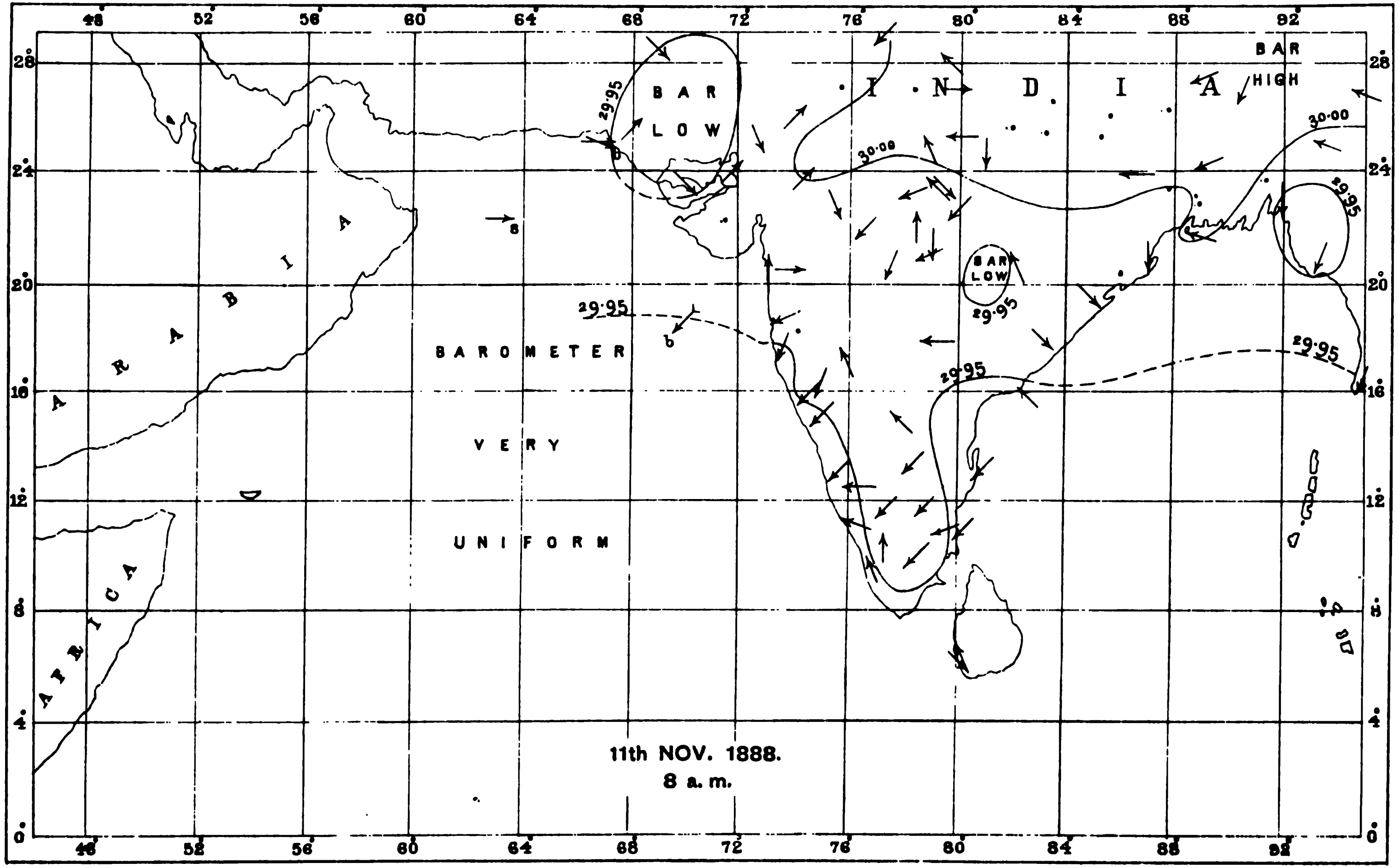
Plate XLVI.



Reg. No. 74. Wr., I.—12 7-90.—465.

Litho. S. I. O.—Calcutta

Plate XLVII.



11th NOV. 1888.
8 a. m.

Reg. No. 7s, Wr., I.—12 7-90.—466.

Litho., S. I. O.,—Calcutta.

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